Axe Monies and Their Relatives

Dorothy Hosler, Heather Lechtman, and Olaf Holm

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DOROTHY HOSLER, HEATHER LECHTMAN, AND OLAF HOLM

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Introduction

The two articles, now classics, that brought American axe-monies to the attention of scholars of New World prehistory were published virtually simultaneously: Olaf Holm's discussion of the Ecuadorian variety, which comments upon its closeness to similar artifacts from Oaxaca, Mexico (Holm 1966/67), and Dudley Easby's more metallurgically technical look at the Oaxacan types, which comments upon their closeness to similar artifacts from Ecuador (Easby et al. 1967). Easby and his coworkers conclude their study thus: "Virtually every author who has written about the examples from Ecuador and Peru considers axe-money to be clear proof of maritime commerce between that area and [the] western [coast of] Mexico. . . . Axe-money has not been reported from the intervening area, so that conclusion strikes us as entirely reasonable and probable" (Easby et al. 1967: 132). Holm, on the other hand, looks southward, suggesting that in the Peruvian region some related phenomenon is to be expected: "The presence of copper money-axes is not safely established in the Peruvian cultures, but we do suspect their presence in f[or] inst[ance] Lambayeque, although in a different presentation" (Holm 1966/67: 142).[1]

Since those publications, the literature concerning axe-monies has been sparse. They have occasionally been reported from Ecuador as issuing

[1]The article by Easby, Caley, and Moazed (1967) concentrates on two aspects of Mexican axe-monies: their use and the methods by which they were made. The small corpus of objects these investigators studied came from the present Mexican state of Oaxaca where such items were reported to have been found in hoards or caches. On the basis of eyewitness accounts at the time of and immediately after the Spanish invasion, and after an exhaustive review of the subsequent available literature, Easby maintained that Mexican *hachuelas* were, without doubt, ". . . a kind of money or unit of exchange in the famous *tianquiztli* or Indian markets. No other possible use is mentioned in any of their [the chroniclers'] accounts of New Spain" (Easby et al. 1967: 110). Caley and Lowell Shank performed chemical analyses of six Oaxacan axe-monies. Their most interesting result (1967: table II) was the determination of arsenic, at concentration levels ranging from 0.30 to 0.51 weight percent, in four of the six, the remainder of the metal being copper with a variety of trace impurities. Moazed's metallographic examination of cross sections removed from four Oaxacan axe-monies demonstrated that the objects had been hammered, not cast to shape, a result that was confirmed later when Easby and Leonard Heinrich fabricated a typical Oaxacan axe-money. Having cast a blank of copper roughly to the shape of an *hachuela,* they hammered and annealed the metal until the final form and appropriate thicknesses of blade, shank, and flanges were achieved.

Holm's 1967 article on Ecuadorian axe-monies draws entirely upon internal evidence presented by the objects themselves, since he knew of no ethnohistoric sources then—nor do we know of any now—that describe the use of such axe-monies in Ecuador at the time of the Spanish invasion. Nevertheless, their axe-like shape, their thinness, and the presence of raised flanges along their borders were all features close enough to those of the Mexican variety for him to suggest a similar function. He presents a typology of the basic axe-money shapes, describes all the types as having been fashioned by hammering, plots their distribution within the Manteño/Huancavilca culture area of the central Ecuadorian coast (where they are found in large quantities) and down as far as Tumbes on the far north coast of Peru, and sets the Ecuadorian material chronologically within the Integration period (ca. A.D. 800/900–1500). Concerned to discover any standard unit against which these objects had been made, Holm examined several hundred examples and attempted to seriate them by weight. He reports that the weights appeared to concentrate in groups around a quinary system—5, 10, 15 . . . grams—and speculates upon whether or not such fractionary values might have been of commercial or measuring significance. Considering the possible monetary use of these items, Holm remarks: "All the specimens which we have described do fit well into the basic requirements of primitive money, they are portable, they do have intrinsic value and they are well recognizable . . . " (1967: 138). With respect to the last of these characteristics, he singles out the raised flanges and hammered superficial striations on Ecuadorian axe-monies as legitimating devices. Like the Mexican variety, Ecuadorian axe-monies were found in hoards, often in graves, indicating that wealth in copper was accumulated as well as traded over considerable distances.

from controlled excavations (Ubelaker 1981; Marcos 1981); they have been suggested as examples of the kind of copper money Chincha merchants are reported to have used in their maritime commerce between the central coast of Peru and Ecuador (Oberem and Hartmann 1982; Shimada 1985a; Rostworowski 1970, 1988); and a fruitless attempt has been made to establish a relation between Ecuadorian axe-monies and the ancient Mexican system of weights, known ethnohistorically, based on the cacao bean (Szászdi 1980). Very recently a few publications have paid somewhat closer attention to these unusual artifacts. Mayer (1982a) considers them in a brief survey of ancient American money and related goods made of metal; Morse and Gordon (1986) report on their metallographic examination of three typical Oaxacan axe-monies; and Prümers (n.d.) presents arguments for including artifacts with provenience as far south as the Chillon valley, on the central coast of Peru, in a broadly drawn definition of axe-monies.

There are several good reasons to reconsider axe-monies at this time, from a fresh vantage point. Chief among them is the publication of a major study by Dorothy Hosler on the origins, technology, and social construction of metallurgy in ancient West Mexico (Hosler 1986, 1988a, 1988b, 1988c, n.d.). Hosler establishes unequivocally that metallurgy was introduced directly to West Mexico from Ecuador and Peru via a maritime route and that that introduction included not only a certain constellation of object types but almost the entire range of metals and alloys in common use in the central and northern Andes. What moved from the Andes to Mesoamerica was neither finished objects (with a few exceptions) nor stock metal. Rather, the knowledge and technical know-how behind mining, smelting, and the manipulation of metal; an interest in producing certain classes of objects, such as needles, tweezers, open rings, and axe-monies; and specific attitudes about the qualities of metal as a material—its color, for example—that were important in channeling West Mexican cultural investment in the new medium, were what West Mexicans took from their distant neighbors to the south.

Axe-monies were among the Andean object types that interested West Mexican peoples, which is not surprising in view of the cultural significance of the metal axe among Mexican societies. Axes made from metal appear frequently in ethnohistoric documents as items of ritual paraphernalia associated with gods and rulers (Hosler 1986). Mexican smiths tended to make axe-monies from copper-arsenic alloys,[2] the same alloy system that typifies the Ecuadorian variety of axe-money (see Table 2), though the Mexican shapes are quite distinct. Some time around A.D. 800–900, just at the time that West Mexico had its first experience with metal (Pendergast 1962; Hosler 1986, 1988b), a certain style in handling this material became prominent along the Peruvian north coast and in coastal Ecuador. The production of relatively small objects which could be stacked, packeted, tied, or bundled, from metal sheet that was at times paper thin, became joined to the elite use of such objects, to their circulation and eventual hoarding in large numbers, and to some system of

[2]There is no commonly accepted terminology which describes the binary alloys of copper and arsenic. Metallurgists refer to all such alloys as arsenical copper, regardless of the amount of arsenic alloyed with the copper. Lechtman (1981) introduced the term arsenic bronze to refer to alloys of copper and arsenic whose mechanical properties are close to those of the tin bronzes. Throughout this article we have adhered to a terminology which relates the arsenic concentration of a copper-arsenic alloy to the mechanical properties of the alloy, in the most general sense: arsenical copper ($<\approx 0.1\%$ As); low arsenic copper-arsenic alloy ($\approx 0.1\%$–$\approx 0.5\%$ As); arsenic bronze (≈ 0.5–$\approx 10\%$ As). Alloys containing more than 10 weight percent arsenic are arsenic bronzes, but they rapidly become too brittle to work cold. Such alloys were used in West Mexico, for example, for casting objects such as bells. These alloys and the objects cast from them are a rich silver color (see Hosler 1986, 1988a).

We consider arsenical copper as copper containing arsenic in concentrations lower than about 0.1 weight percent. Such alloys are impure coppers whose electrical properties are markedly affected by the presence of arsenic but whose mechanical properties are similar to those of copper alone. Mechanical properties of copper-arsenic alloys, such as hardness and malleability, begin to change appreciably with arsenic concentrations of about 0.5 weight percent. At these relatively low arsenic levels the overall strength of the alloy increases, with considerable gains in hardness especially when the alloy is cold worked (Lechtman, personal communication). At arsenic concentrations of about 0.5 weight percent and higher, copper-arsenic alloys can be considered bronzes (Lechtman 1981).

It should be noted, however, that the term arsenical copper is used widely in the literature on ancient metallurgies to refer to all binary alloys of copper and arsenic, regardless of their composition.

value that apparently prized not just the objects but the copper-arsenic alloy of which they were made. This style of manipulating the alloy was played out in the northern Andes (Ecuador) in the manufacture of the prototypical axe-money (Figs. 1, 2) and, in the north central Andes (Peru), in the design of its closest relative, the *naipe* (Figs. 3a, 4), the Peruvian manifestation of "axe-money" whose presence Holm had predicted correctly (Holm 1966/67). When this metallurgical style reached West Mexico at about A.D. 1200 (Hosler 1986, 1988b), it was elaborated in the form of the axe-money (Figs. 5, 6, 7), not as *naipes* or as feathers, the two stack-packet forms that were prominent in the north central Andes at the time. Axe-monies may be particularly useful, then, in helping establish the north Andean role in disseminating metallurgical technologies and styles during this dynamic period of coastal Pacific interchange (see map, Fig. 8).

Another reason for a closer look at axe-monies stems from the clear picture we now have of the way in which they were made. The technical study of Oaxacan axe-monies carried out by Easby, Caley, and Moazed (1967) is still useful, though it does not examine any of the West Mexican artifacts, some of which are unique to these Pacific coast states and bear important similarities to Ecuadorian and Peruvian thin-style smithing. Hosler's metallurgical studies (1986, 1988a, 1988b) corroborate many of Easby's findings and go much further in establishing the near-exclusive use of copper-arsenic alloys for the production of both West Mexican and Oaxacan types (see Table 2). She deals with a large and diverse corpus of objects (see Table 3), with their function, both utilitarian and social, and with the question of standardization in production, and relates alloy composition to the probable use of these items. Hosler also provides additional ethnohistoric data, especially for West Mexico. Furthermore, we can provide for the first time a detailed reconstruction of the smithing sequences that resulted in the Ecuadorian corpus, by far the largest group of axe-monies available from the Americas. All, without exception, are made of copper-arsenic alloy (see Table 2), including the tiniest artifacts (Fig. 11) hammered into foil 20 microns thick (1 micron = 10^{-3} mm). Our laboratory examination of representative objects from Ecuador included also examples of their closest stack-packet, thin-style Peruvian relatives, *naipes* and feathers (Figs. 3a, 9). These too, we found, are made of extremely thin sheet, hammered from copper-arsenic stock metal (Table 2; see also Shimada 1985a for chemical analyses of *naipes*).

Finally, axe-monies and their relatives deserve particular scrutiny in view of the suggestion made recently by Izumi Shimada that the copper-arsenic alloys of which the Ecuadorian artifacts and the Peruvian *naipes* are fashioned were produced and distributed in the form of "blank sheets, ingots of copper and arsenical copper" (Shimada 1985a: 390) by the Middle Sican polity based in the Lambayeque valley of north coast Peru. The archaeological investigations of Shimada and his colleagues at various sites within the La Leche-Lambayeque river drainages (Shimada 1985a, 1987b; Shimada et al. 1982, 1983; Epstein and Shimada 1983) demonstrate clearly and conclusively the serious investment in the production of copper-arsenic metal at large ore smelting (or refining) centers closely linked to the Sican economic and ceremonial hub at Batan Grande. Shimada believes that *naipes,* which he likens to Ecuadorian axe-monies, were a form of primitive money and that their similarity to the Ecuadorian objects indicates trade between Ecuador and Peru during the tenth and eleventh centuries (Shimada 1985a, 1987a). He argues further that the alloy-producing Middle Sican polity probably controlled ". . . not only the goods being distributed but the transport mechanisms themselves" (Shimada 1985a: 391), trains of llamas and ocean-going balsa rafts off the Pacific coast. Whereas Hosler (1986, 1988c) has shown that such maritime traffic was the chief mechanism by which metallurgy as a technical and conceptual system moved from the northern Andes to Mesoamerica, we shall concentrate here on the axe-money as representative of that system and, perhaps, as the artifact type that bears best witness to its roots.

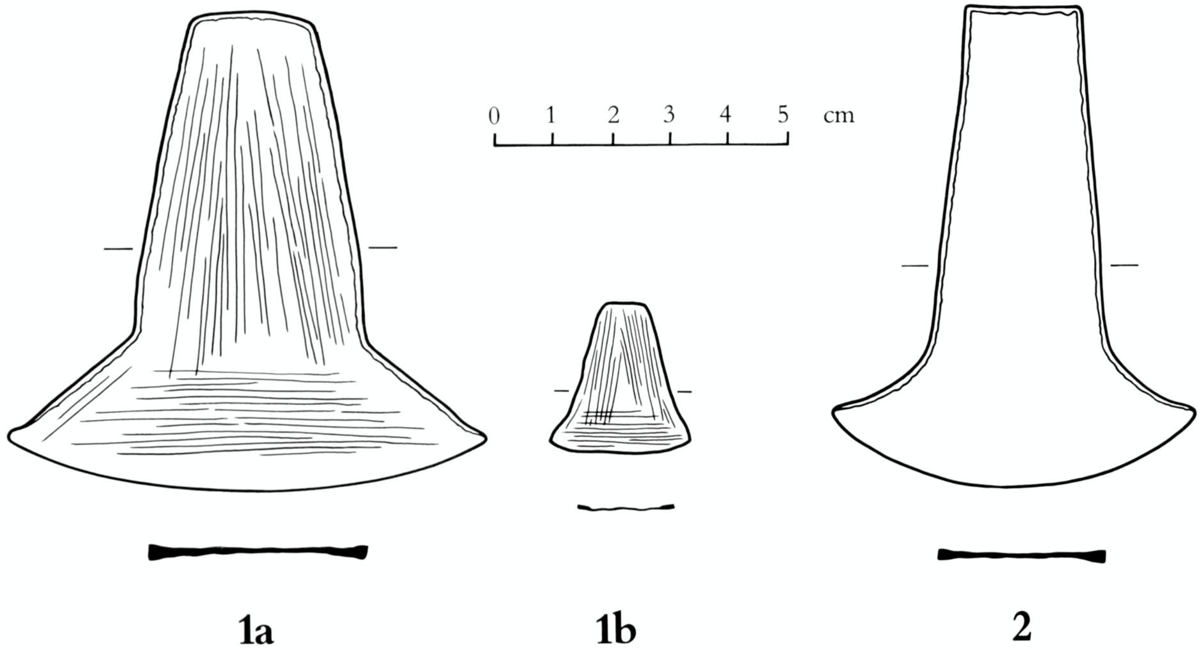


Fig. 1 North Andean axe-money types. Type 1a always has surface striations; only the tiniest Type 1b items lack striations. Type 2 axe-monies sometimes bear striations but often do not. Drawing by S. Whitney Powell.

Fig. 2 Type 1a axe-money from the site of El Barro, Ecuador. Collection: Museo Antropológico del Banco Central del Ecuador, Guayaquil, Ecuador (MIT 3310).

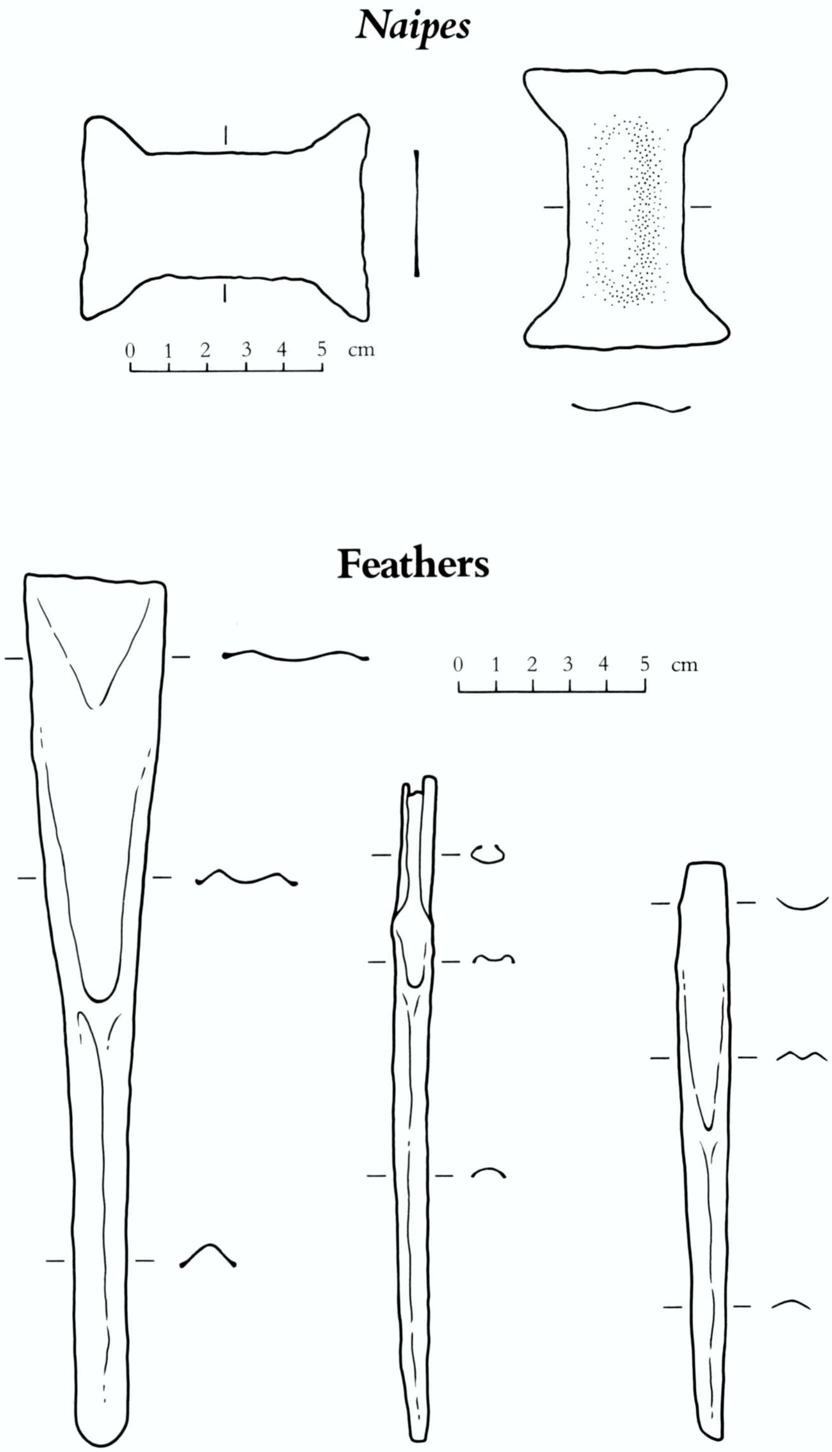
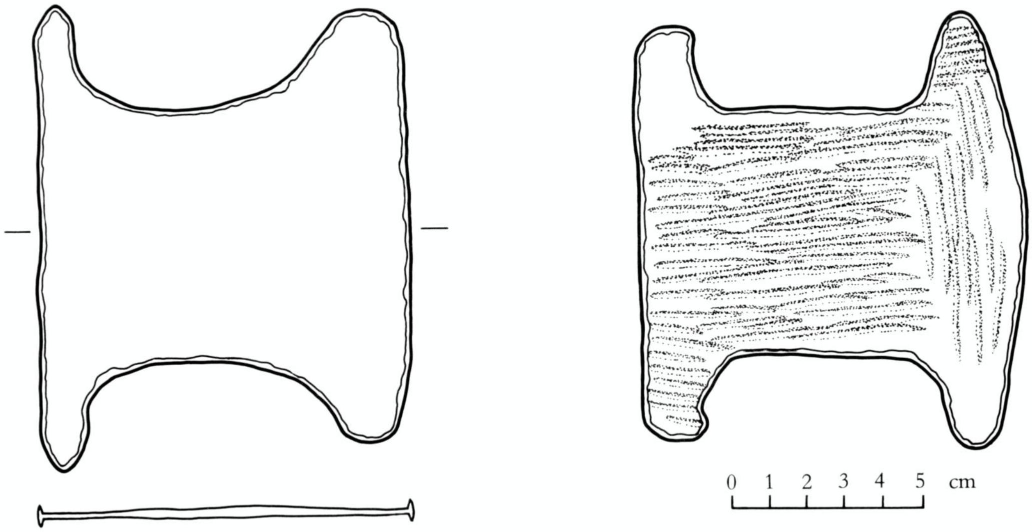
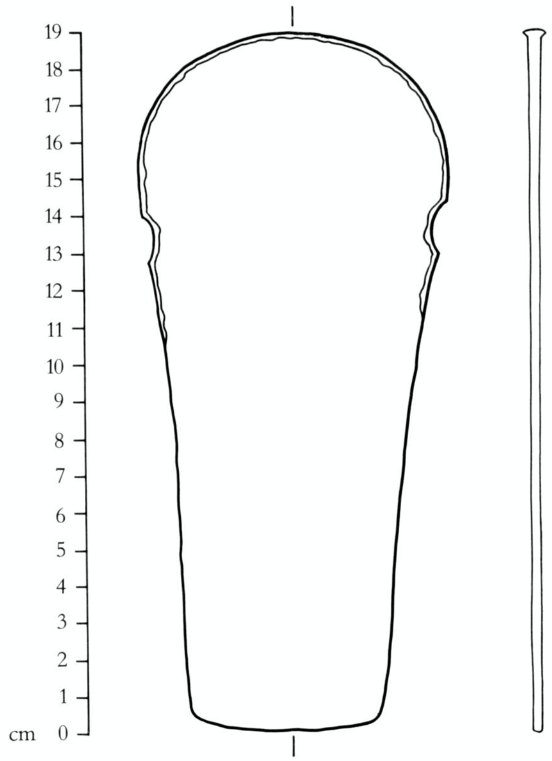


Fig. 3 Relatives. a) *Naipes:* The example at the left is flat; the one at the right has a central oval "bubble." Feathers: The socket-end type (middle) has been found in Peru and Ecuador; the spatulate-end type (left and right) is known only from Peru. b) "Hides" and insignia. The "hide" at the right is shown with surface striations. Not all "hides" of this shape bear striations. Drawing by S. Whitney Powell.

"Hides"



Insignia



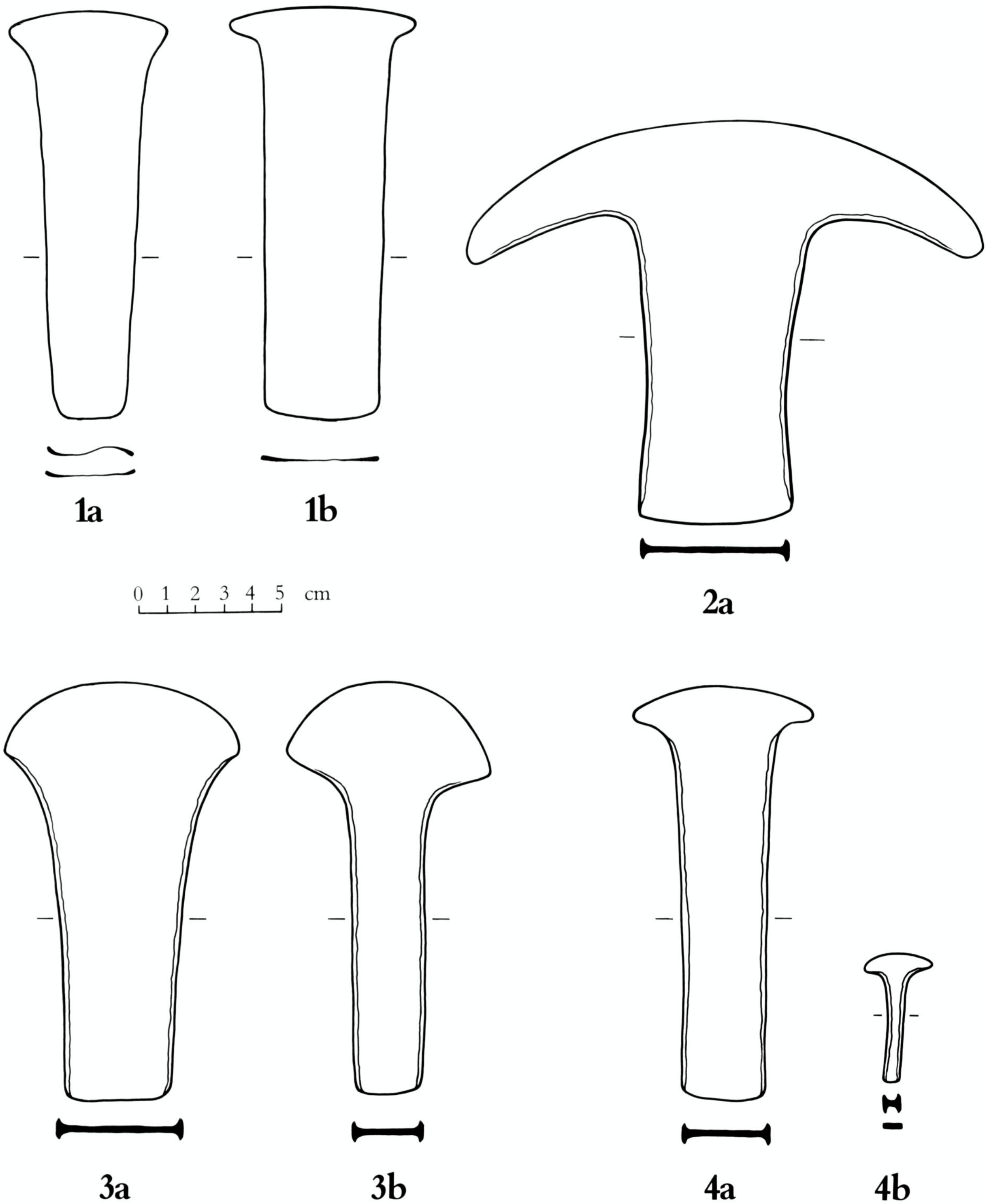
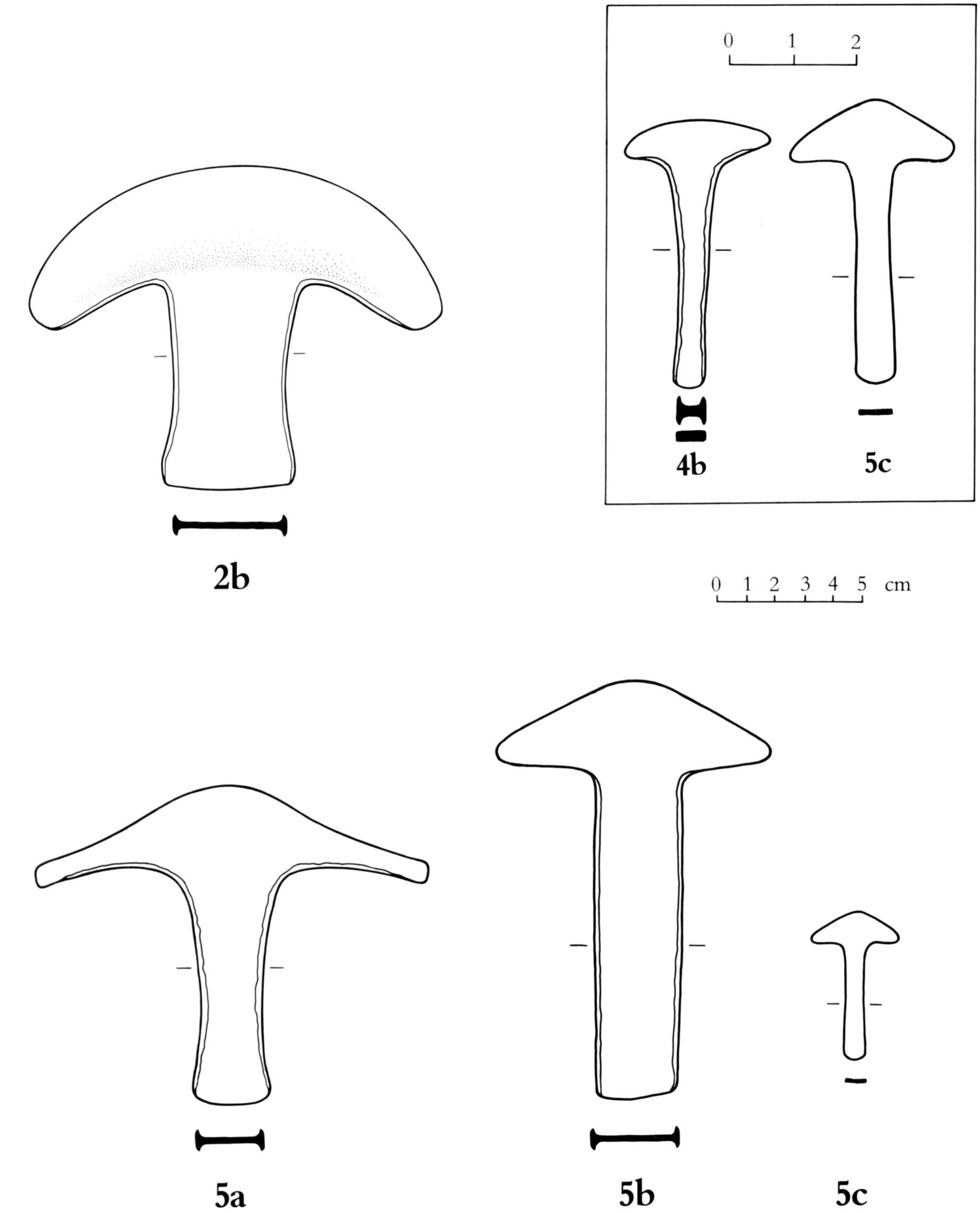


Fig. 5 Mexican axe-money types. The forms illustrated can be considered standard for each type, but there is often variation in size and shape within a type. Type 1a is found almost exclusively in West Mexico. As its two transverse sections indicate, some are flat but others describe a wave pattern. The cm scales in these drawings permit measurement of the overall dimensions of each axe-money type but not its cross section thickness. The form of each cross section is rendered accurately (including ratio of flange height to body thickness); its thick-



ness is presented as a line whose width is relative to that used to describe Type 1a, the thinnest variety. Thus Type 1b is presented as virtually the same thickness as Type 1a; Type 5c is drawn 3x as thick; all the other types are drawn with a thickness 7x that of Type 1a. The relative thickness of shank and flange for Types 2a through 5b represents a mean value of this ratio for these axe-monies, but the variation around the mean is small. Drawing by S. Whitney Powell.

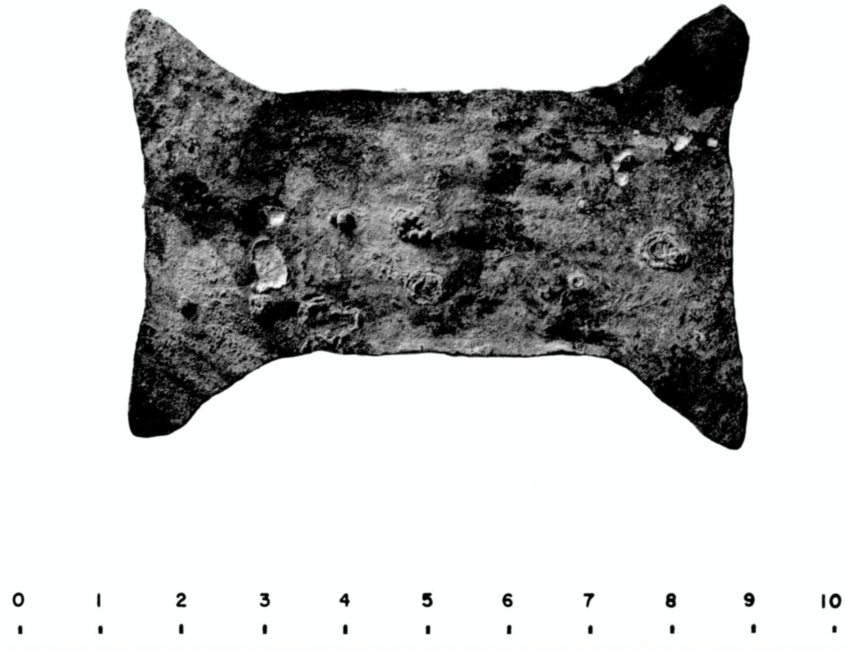


Fig. 4 *Naipe,* Vicus, Peru. This is an example of the flat type of *naipe*. Collection: Gift of Henry Reichlen to the Laboratory for Research on Archaeological Materials, MIT (MIT 3412).

Fig. 6 West Mexican Type 1a axe-money, Guerrero, Mexico. Note the shallow corrugations that run longitudinally along the length of the blade and the half wave contour of the thin sheet. Collection: Gift of Dudley T. Easby, Jr. to the Laboratory for Research on Archaeological Materials, MIT (MIT 196).

Fig. 7 Type 2a axe-money, Oaxaca, Mexico. Collection: Museo Regional de Guadalajara, Guadalajara, Mexico (MRG F247; MIT 3460).

Fig. 8 Map illustrating the regions of western Mexico, the north Andean area, and the central Andean zone mentioned in the text. The West Mexican states of Nayarit, Jalisco, Colima, Michoacan, and Guerrero appear as an inset, along with the state of Oaxaca.

Fig. 9 Feathers of socket-end and spatulate-end type from the Lambayeque valley, Peru. Collection: Museo Arqueológico Brüning, Lambayeque, Peru. Photo courtesy of Eugen Mayer (1982a: fig. 4; we have added a scale and rearranged the order of the objects).

Axe-monies and Relatives

If we leave aside the possible uses of the objects under review here—as functional implements, as primitive money, as tribute items, as headdress paraphernalia, as status symbols and ritual offerings—and concentrate only upon their archaeological and metallurgical characteristics, the salient features that describe them and that cluster them analytically are:

1. Shape	Predominantly axe-like
2. Metal composition	Copper-arsenic alloys (arsenic bronze); occasionally impure copper
3. Fabrication procedure	Hammered, to form thin plate, sheet, or foil
4. Physical features	Mechanical strengthening devices, such as raised flanges along edges, thickened edges, corrugations
5. Archaeological deposition	Primarily grave goods in single or multiple burials; caches
6. Deposition features	Found in groups, often in large hoards; sometimes bound in packets or wrapped in bundles

Axe-monies of the Ecuadorian and Mexican types (Figs. 1, 5), the north coast Peruvian *naipes,* and a feather form known from Peru and Ecuador (Fig. 3a) share most of these features and constitute our inclusive group of "axe-monies and relatives." Under the same set of considerations, certain object types fall outside the core group: cast objects, such as the giant copper-arsenic axes from Ecuador, illustrated here in Figure 10 (Holm 1966/67: fig. 4), and hoards of heavy, cast and socketed copper-arsenic points from north coast Peru (Lechtman 1981), as well as bound packets of bits of hammered metal sheet—sometimes folded scraps, sometimes shaped forms—of copper, silver, gold and their alloys (Prümers n.d.; Mayer 1982b). By definition, we consider axe-monies as those objects in our core group that meet all six classification features listed above. Their relatives, which depart in certain ways from complete fit in all features, are *naipes,* feathers, and several of the objects Holm included as axe-monies in his original classification, where he groups them as "aberrant types" (Holm 1966/67: 139, fig. 3), and which we have termed "hides" (Figs. 3b, 20, 21) and insignia (Figs. 3b and 22).

Axe-monies: Ecuador

Figure 1 illustrates the axe-money types that are found in large numbers along the central and south coasts of Ecuador. Type 1a is most common. The largest of these range in height from about 7.7 to 8.9 cm and appear to have been the normal or standard size (Fig. 2). Small axe-monies measure from about 6.5 to 6.9 cm, and tiny axe-monies can vary from 1.2 to 4.5 cm in height. The normal and small sizes are identical in shape and were buried as individual items, though often in great quantity. The tiny axe-monies, Type 1b in Figure 1, usually have lost the pronounced shoulder of the blade and tend to assume a triangular form (see Figs. 11, 12).

They are almost always found stacked and in packets, either tied or corroded together (Fig. 12). Type 2, though less commonly found, is close to Type 1a in shape and size, but the angle formed by the shoulder to the blade is less abrupt and the blade more flaring. Type 2 shares the formal characteristics of the Type 3a variety of Mexican axe-money (see Figs. 5, 29).

The distinguishing characteristics of these artifacts are their thinness (thickness determinations made microscropically on cross sections of samples taken from selected objeccts yielded the following measurements for representative normal, small, and tiny axe-monies; all measurements were made interior to the raised flanges: θ_n = 0.055–0.12 cm; $\theta_s \simeq$ 0.011 cm; θ_t = 0.0022–0.014 cm); the presence of an uninterrupted raised flange along the butt, shank, and shoulder edges; a blunt, squared-off blade edge; and a series of striations or grooves indented into the surface metal on both sides of the object which run along the length of the shank and across the width of the blade. The flanges and grooves were recognized by Holm (1966/67: 137) as legitimating devices, visual and tactile clues by which the objects could be recognized for what they were. The tiny axe-monies are too thin to support raised flanges, but their edges have been thickened deliberately to provide greater mechanical strength to the thin sheet or foil. But even the smallest examples bear the identifying grooves (Figs. 11, 12; see also Ubelaker 1981: fig. 102). To this list we can now add a further identifying characteristic to the typology: the use of copper-arsenic bronze for the manufacture of Ecuadorian axe-monies. In all of the analyses we have carried out, reported here in Table 2 and Figure 51a, as well as in those of Scott (n.d.) on the single example Bushnell collected on the Santa Elena Peninsula (Bushnell 1951), and of Minato (1960) on an excavated example from Garbanzal, Peru, the manufacturing material has been copper-arsenic alloy, without exception: Cu, 2.1% As in the latter case, Cu, 0.33% As in the former. The addition of arsenic to copper strengthens the alloy and changes its color. The strengthening effect becomes useful at arsenic concentrations of about 0.5 weight percent and higher, particularly for objects like axe-monies that are hammered to shape, since the presence of the alloying element (arsenic) enhances the work-hardening of the metal. With the addition of as much as 3.5% arsenic, the rich red color of copper changes to a pale pink, and alloys containing 7% and more arsenic are silvery white (Lechtman 1988, and personal communication; Hosler 1986, 1988a; see also notes 2 and 10, this volume).

Within the modern political boundaries of Ecuador, these kinds of axe-money have been found principally in the provinces of El Oro, Manabi, Los Rios, and Guayas, which correspond geographically to the prehistoric culture areas associated with the Manteño-Huancavilca presence along the Pacific littoral and the Milagro-Quevedo peoples who occupied the territories somewhat farther inland. These societies flourished during the so-called Integration period, from about A.D. 800–900 to the Spanish invasion in the early sixteenth century (see Table 1).[3] The map of Figure 13 indicates all sites at which finds of axe-monies have been reported in the literature or identified in the field by archaeologists, farmers, and *huaqueros*. During the course of this study, we have performed chemical and metallographic analyses on representative examples from 30% of the sites indicated. The map includes the present Ecuador-Peru border area, since a few finds of Ecuadorian style axe-monies have been found at Garbanzal, just 7 km south of Tumbes (Mejía 1960; Ishida 1960), and near Talara (Bushnell 1951). This repre-

[3]The chronological chart for Ecuadorian prehistory published by Evans and Meggers in 1961 was based on 36 radiocarbon dates derived from samples of charcoal and shell. Twenty-one of these dates (20 from Valdivia sites; 1 from a Chorrera site) correspond to the Formative period; 11 represent the Regional Development period; one was derived from material that can be considered transitional between the Regional Development and Integration periods; and three dates came from material associated with the Integration period (Manta context). This valuable compilation of C-14 dates is the only published summary available for Ecuador, but we note that only four dates (11% of the total) correspond to the chronological and cultural interval that pertains to axe-monies. In the 38 years since the publication of Evans' and Meggers' important study, many additional dates have been published by individual investigators, but no up-to-date summary of these new data has appeared. The chronological and cultural chart we present in Table 1 is generally accepted by scholars of Ecuadorian prehistory to represent the current state of research on the subject.

sents the southernmost limit of the occurrence of the Ecuadorian *hacha-moneda*.

All Ecuadorian axe-monies are grave goods interred in single or multiple graves (Mejía 1960; Marcos 1981; Stothert n.d.a; Netherly, personal communication, 1988, concerning excavations at El Porvenir, Arenillas valley, El Oro) and in urn burials (Ubelaker 1981). Most of the dramatic finds described by Holm (1980)—such as a total of 30 kg of axe-monies deposited in ceramic vessels at Hda. "Los Alamos," El Oro; a ceramic vessel, currently in the collections of the Museo de Arte Prehistórico, Casa de la Cultura, Guayaquil, with hundreds of tiny axe-monies in packets of 20 from Plagosa, Manabi; over 13,000 axe-monies of normal size buried in a single vessel at Hda. "El Retiro," El Oro—have been located through the activities of *huaqueros* or in chance finds by farmers. In those few cases in which they were uncovered as part of archaeological excavations, they are described as occurring in close association with the human skeleton. Mejía (1960) reports 18 individual axe-monies located on both sides of the skeleton in a grave he dug at Garbanzal, on the far north coast of Peru. In the case of the Manteño-Huancavilca burial Stothert (n.d.a) uncovered at El Tambo, near La Libertad, each hand held one axe-money and six others were stacked nearby, whereas at El Porvenir in the middle Arenillas valley, Netherly excavated the burial of a six-year-old child with four axe-monies placed closed to the head (Netherly, personal communication, 1988). Marcos (1981) describes the normal size axe-money as present at Loma de los Cangrejitos in all graves he excavated which belong to the Phase A (ca. A.D. 900–1150) utilization of the site. The axe-monies were generally placed in the hands of the body but occasionally also in the mouth. He reports further that the normal size axe-money almost disappears in Phase B (end of twelfth to onset of fifteenth century A.D.) of the Manteño-Huancavilca necropolis and is absent in Phase C (fifteenth to end of sixteenth century A.D.), whereas the tiny axe-monies that measure 2–3 cm in length and occur grouped in packets of 20 are extremely frequent in Phase B and are also found in the earliest burials in Phase C, until about A.D. 1400 (Marcos 1981; 55, 57; personal communication, 1988). Ayalan, a Late Integration period urn burial cemetery in the Province of Guayas, was in use between about A.D. 710 and 1600, but the pre-Spanish materials date principally from A.D. 710 to A.D. 1230. Ubelaker's excavations there yielded 54 ceramic funerary urns and 25 primary skeletons without urns (Ubelaker 1981: 9). The metal artifacts found most frequently at the site were axe-monies (he refers to them as copper plates), and it is worth quoting his careful description of their occurrence (Ubelaker 1981: figs. 101, 102, 103).

> . . . groups of small triangular copper plates, [are] frequently bound together by yarn tied around the base . . . Of the 69 groups recovered, 28 (41 percent) display the yarn binding and/or associated fabric. Analysis of the yarn content . . . revealed brown single-ply yarns, one with a "Z" twist and all others with an "S" twist. All specimens examined microscopically appear to be cotton.
>
> A total of 69 groups of plates were recovered from eight features within the cemetery. . . . Since decomposition had destroyed many plates . . . exact plate counts were possible for only seven groups, each of which contained 5, 10, 10, 20, 20, 20, and 20 plates. . . .
>
> Plate groups were found with urns (2 features), primary skeletons (6 features), and one secondary skeletal deposit. Within the urns the plates were usually concentrated in the base. With the primary skeletons, plates were recovered from four males and two females and from nearly all parts of the skeleton (feet, legs, pelvis, arms, skull, etc.). (Ubelaker 1981: 100–101)

At least 778 axe-monies were recovered, of which a few were of normal size, the latter found both with urns and with skeletons. Ubelaker does not mention any grouping of types as a function of chronology, however, as is the case at Loma de los Cangrejitos. Holm (1978: 351) also cites cases in which normal and tiny axe-monies are found in the same grave.

In general, the farther away from the nuclear coastal area the site is located, the fewer axe-monies it yields. Finds of hundreds, at times thousands, are typical in the central Milagro-Quevedo/Manteño culture area, whereas sites along its geographic margins are limited to a few specimens. Holm (1966/67) has received reports of isolated and unique finds of axe-monies from the provinces of Imbabura, Chimborazo, Cañar, and

Azuay in the Ecuadorian highlands, but we have seen none.

Axe-monies: Mexico

Figure 5 illustrates the proliferation of axe-money forms that Mexican societies elaborated after the basic notion, style, and use of this class of artifact were introduced to West Mexico from Ecuador (Hosler 1986, 1988c). The transmittal from Ecuador to West Mexico of metallurgical technologies and the knowledge involved in ore mining, smelting, and metal manipulation occurred in two rather distinct phases. The first, a copper-based metallurgy, began at approximately A.D. 800 and continued until A.D. 1200–1300. The second, an alloy-based metallurgy which included the binary copper-silver alloy, the copper-arsenic and copper-tin bronzes as well as a ternary copper-arsenic-tin alloy, Hosler places at A.D. 1200–1300 until the Spanish invasion (Hosler 1986, 1988c). Axe-monies were a phenomenon of the second wave.

Although all of the presently known Mexican types are shown in Figure 5, our discussion here focuses on the West Mexican variety, since it was through West Mexican hands that metallurgy as an activity and notions about metal and its proper cultural use were disseminated through the Mesoamerican region (Hosler 1986), and because we are interested precisely in the nature of the technological and cultural relations between the Andean zone and Mexico. The Oaxacan material has been amply treated by Easby and his associates (Easby et al. 1967).

West Mexican smiths sometimes produced object forms in metal identical with those that came from the south, whether from the Andes or, in the case of lost wax cast bells, from Central America. More typically, they transformed them and, with a characteristic flair, produced many variations on the theme (Hosler 1986, 1988a, n.d.). This is as true for axe-monies as for depilatory tweezers and bells, yet virtually all the identifying characteristics of the Ecuadorian axe-money are present: axe-like or knife-like form; fabric of thin plate or sheet; raised flanges along the shank edges and in most cases along the shoulder of the blade, though rarely on the butt edge;[4] a blunt, squared-off blade edge on some types (notably Type 2a) but a sharp blade edge on others (e.g., Type 3a). The large majority—84% of those analyzed by Hosler (1986)—is made of the alloy of copper and arsenic (see Table 2): 16 out of 19 (84%) artifacts analyzed from West Mexico (Hosler 1986); 20 out of 25 (80%) artifacts analyzed from Oaxaca (Hosler 1986; Easby et al. 1967: table II). The only feature present on virtually all Ecuadorian axe-monies that is entirely missing from the Mexican corpus is the linear grooving of the surfaces. As in the Ecuadorian case, extremely small examples of certain normal size forms were produced (Types 4b and 5c in Fig. 5); some of these have raised flanges, others have not.

Axe-monies constitute one of the most abundant metal artifact types in Mesoamerica, along with bells and open loops. However, they have rarely been found in archaeological contexts. Of the varieties illustrated in Figure 5, Type 1a is known almost exclusively from West Mexico where it is common to the states of Guerrero and Michoacan and to the Guerrero-Michoacan border (Hosler 1986). For our discussion here, we include Guerrero among West Mexican states. Few have been found in the state of Oaxaca which has yielded all the other types.[5] Type 1a (Fig. 6), discussed here for the first time (reported in Hosler 1986, 1988c), is of particular interest because, except for the absence of raised edge flanges, it is in many respects closest to the production style we have outlined for the Ecuadorian artifacts. These

[4]Type 2a axe-monies occasionally have a raised flange along the butt edge. This is not indicated in the typology illustrated in Figure 5.

[5]Hosler reports 14 Type 1a axe-monies from Oaxaca out of a total of 100 Type 1a objects in the collection of the Museo Regional de Guadalajara, Mexico (1986: 298). The analyses of six of these are presented here in Table 2. The objects are interesting because as a group their composition falls at the high end of arsenic concentration when compared with the total population of Mexican axe-monies (see Fig. 50). At the same time, they are considerably larger than the other Type 1a axe-monies—all of which are from West Mexico—with lengths that range from 17.6 to 20.5 cm (mean length of 19.6 cm; see Table 3). By contrast, the mean length of 51 Type 1a axe-monies from West Mexico is 15.0 cm, with a range of 12.2–17.2 cm (Hosler 1986: appendix 6.1–1).

long, paper-thin axe-monies are hammered to shape from sheet whose thickness averages only 14 microns (0.014 cm). Their thickened shank edges and their slightly corrugated construction, evident in the x-radiograph of Figure 14, are deliberate mechanical devices to increase rigidity of the long and thin sheet, thereby ensuring integrity of the form. In some cases the sheet describes a half-wave pattern along its longitudinal axis (see Fig. 5), a feature which may perhaps have aided in stacking these items but which definitely improves their strength. Of 25 Type 1a axe-monies analyzed by Hosler (1986), only two were found to be of copper. All the others are fashioned from copper-arsenic alloy in the concentration range between 0.05 and 6.4 weight percent, with the mean at 2.6% (see Table 2 and Fig. 50).

The only report we have of the stack-packet assembly of axe-monies in Mexico refers to this extremely thin Guerrero variety. During his archaeological explorations in Naranjo, central Guerrero, Weitlaner surface-collected ". . . a package of 13 copper leaves [*láminas*] in the form of an axe but the thickness of heavy paper about whose use we were unsure" (1947: 79; translation by Hosler). Villagers whom Hosler interviewed at Xochipala, Guerrero also refer to them as *láminas* when they find them (Hosler 1986).

Of the other Mexican axe-monies illustrated in Figure 5, only Type 2a has been reported occasionally from West Mexico, in Guerrero (Hosler 1986) and in Michoacan (Ortiz Rubio 1920). Types 2 and 3 have rarely been found in controlled excavations, apart from a group of five Type 2a objects excavated at Monte Alban (Caso 1965). They are sometimes found in caches, however. One lot (Type 2b) given by Saville to the American Museum of Natural History, for example, came from a cache of 120 found in pairs in a mound near Xaaga, Oaxaca (Saville 1900), and 23 dozen were reported found in a terra-cotta pot near the city of Oaxaca (Easby et al. 1967).

With regard to physical characteristics, it is interesting to note that the mean length of the three primary types in a group of 174 axe-monies examined by Hosler—1a (thin, straight shank: 65), 2a (curved blade: 72), and 3a (flaring blade: 37)—is almost identical, 15.0 cm, 13.8 cm, and 14.0 cm respectively, as are the mean weights of Types 2a and 3a: 55.1 g and 52.9 g (Hosler 1986; see Table 3). The Type 1a axe-monies average only 5.7 g in weight. The thickness of Type 2a and 3a objects ranges between 0.04 and 0.1 cm, with a mean of 0.07 cm for both types. All Mexican axe-monies have raised flanges along the shank edges except for West Mexican Type 1a, Type 1b, and the miniatures of Type 5c which are too thin to undergo such mechanical treatment. Of eight Type 2a objects analyzed by Hosler (1986), one is of copper and the others range from arsenical copper to arsenic bronze; of four Type 3a objects she analyzed, all are arsenical coppers or very low arsenic, copper-arsenic alloys (see Table 2).

Relatives: *Naipes*

The *naipe,*[6] perhaps the closest and most significant relative to the Ecuadorian axe-money, is a phenomenon of the Lambayeque valley complex, formed by the drainages of the La Leche, Reque, and Lambayeque rivers on the far north coast of Peru. Until very recently we have known of only a single example found outside this zone, a *naipe* (Fig. 4) collected by Henry Reichlen, though without association, at Vicus (Henry Reichlen, personal communication, 1976)—a site in the upper Piura valley region, bordering the Sechura desert and approximately 30 km east of Piura—which he gave to Heather Lechtman for study at MIT. During a 1988 site survey of the upper reaches of the Piura river, Shimada, Kaulicke, and Makowski (Shimada n.d.b) collected some *naipes,* associated with Middle Sican blackware bottles, at Buenos Aires (just upvalley of Morropon), and listened to accounts of local *huaqueros* who reported frequent

[6]Looters (*huaqueros*) operating in the Lambayeque valley region use the term "*naipe*" to refer to objects such as those illustrated here in Figures 4 and 15. Shimada (1985a) introduced the term to the literature. From the brief report of his recent metallurgical survey carried out in the upper Piura valley (Shimada n.d.b), it is not clear whether local looters there who find such objects call them by the same name. The most common meaning of "*naipe,*" a Spanish word, is playing card. As used in the Lambayeque region, then, "*naipes*" would seem to suggest "metal cards."

occurrences of shallow shaft tombs containing black ceramic bottles and packages of *tumis* and/or *naipes* (Shimada n.d.b: 9) at sites along the Piura river as far north as Chulucanas and as far south as Morropon. The first *naipes* recovered through archaeological investigations were excavated by Wendell Bennett in 1936 at a burial site he designated Lambayeque One, located about halfway between the town of San Jose and Lambayeque (Bennett 1939). He describes them as "two identical I-shaped thin plates . . . 7.5 centimeters long; 3 centimeters wide at the center; and 6.2 centimeters wide at the ends" (Bennett 1939: 105). Because he did not illustrate them, these objects have been overlooked, but Lechtman found them carefully drawn in Bennett's field notebooks, which are in the collections of the American Museum of Natural History. They are *naipes* of the standard shape and size. On the basis of the ceramics he excavated at Lambayeque One, Bennett assigned the site to Middle Chimu (1939: 106). Holm, in his early discussion of "aberrant types" of Ecuadorian axemonies, illustrated half a *naipe* without knowing what it was but recognizing certain features it shared with the Ecuadorian material (Holm 1966/67: fig. 3, bottom left). He remarked that a few such broken specimens are known from the Manteño area (1966/67: 139). The object he illustrated was donated to Holm and reportedly came from Manabi province, but no similar find has even been reported from an identified archaeological context in Ecuador.

The first and dramatic presentation of *naipes* as elite burial goods stacked, packeted, bundled and occasionally interred in very large numbers came with the publication by Asbjörn Pedersen (1976) of the contents of a partially looted tomb in the Huaca Menor at Batan Grande. In going through the material the looters left behind as of little value, Pedersen found thousands of *naipes*, among them many packets which contained up to 500 individual specimens ". . . arranged and interlocked in a special way, forming compact blocs" (Pedersen 1976: 64; translation by Lechtman) (see Fig. 15 and Prümers n.d.: fig. 7, a schematic rendering taken from Shimada 1985b: 119). The *naipes* assembled in any one packet were of the same size and shape. Shimada describes this tomb as "enormous" (1985a: 385), and it is no surprise that it has yielded the largest cache of *naipes* discovered thus far at Batan Grande. He goes on to say that "the single specimen [Pedersen] illustrates (1976: fig. 2) is nearly identical in size and form to those we have recovered from various looted tombs at Huaca las Ventanas and the partially looted tomb at Huaca La Merced. A radiocarbon date for the Huaca Menor tomb and ceramics associated with burials containing *naipes* allows us to confidently specify that the *naipes* date to the middle to late Middle Sicán (ca. A.D. 900–1050)" (Shimada 1985a: 386). The C-14 date reported by Pedersen is A.D. 1035 (Pedersen 1976: 60). In Figure 15 we illustrate several *naipes* from the Huaca Menor tomb that Pedersen gave to Olaf Holm; they exhibit a central oblong bubble, whereas the Vicus specimen (Fig. 4) is flat. Given the new chronology established by Shimada for Batan Grande (Shimada 1985a: table 16.1) and the formal characteristics of the blackware vessels Bennett illustrates from the site of Lambayeque One, it is clear that Bennett's temporal designation of his Lambayeque One burials as "Middle Chimú" is appropriate, placing the site and the *naipes* at about A.D. 1100, toward the end of Middle Sican in the Lambayeque valley.

Shimada's work at Batan Grande (n.d.a, 1985a, 1987a, 1987b) provides the best information about variation in burial practice, size, and packeting of *naipes*. Except for minor variations, all *naipes* are of the same shape, but they range in size from about 4.2 × 2.1 cm to 10.0 × 8.5 cm, the latter representing the largest (44 g in weight) salvaged from the Huaca La Merced pyramid (Shimada 1985a: 385; 1987a: fig. 11). The variations in shape include a raised oval area, like a bubble or hump, in the central portion of some, or a slight convex bulging of the two long edges on others (see Fig. 15). Pedersen recognized two main types of *naipe* at the Huaca Menor on the basis of presence or absence of the central raised bubble, and noted that those which present this feature are more numerous than the flat type (1976: 64). He further divided these two types into subtypes according to whether the short edges of the object were

straight, convex, or concave. The most interesting aspect of the packeting of the Huaca Menor *naipes* is that there is no mixing of types: any one packet contains only one subtype (Pedersen 1976: 64).

The *naipes* we have examined at MIT from Batan Grande and from Vicus range in thickness from 0.019 cm to 0.078 cm. They are made of copper-arsenic bronze sheet metal hammered to thicknesses that fall within the range typical of Ecuadorian axe-monies.

The inclusion of *naipes* in Middle Sican burials is common at Batan Grande, but their size and number in any single burial are clearly associated with the status of the deceased (Shimada 1985a: 384–385). The smaller tombs generally contain only one set of *naipes* of a certain size, such as a packet of "some 20 small . . . specimens" in an adult male burial at Huaca Las Ventanas (Shimada 1985a: 385). Larger and richer tombs have a variety of sizes and a larger overall number of specimens (Shimada 1985a: 384–385 and pl. 16.2). Shimada reports packets of small *naipes* as "wrapped in coarse cotton cloth and cords of plant fiber" (1985a: 385). In the opulent but rare burial Pedersen described, *naipes* represented only a portion of an estimated 500 kg of copper artifacts interred with 17 bodies (Pedersen 1976), in addition to substantial discrete layers of *Spondylus* shell, lapis lazuli, and cinnabar, among other special materials.

Naipes have a variety of features in common with Ecuadorian axe-monies. They are burial goods which were made in a range of sizes and often stacked and packeted, bound and sometimes bundled in cloth when buried. All of the specimens we have analyzed are made of copper-arsenic bronze (see Table 2), as are those whose composition Shimada and his colleagues determined (Shimada 1985a: table 16.3). Arsenic content of individual *naipes* ranges from 1.15 to 4.47 weight percent; the independent determinations made by the two laboratories[7] (MIT: atomic absorption spectrophotometry; MASCA: proton induced x-ray emission) are in close agreement.

[7]The proton induced x-ray emission (PIXE) analyses reported here as undertaken by the MASCA laboratory of the University of Pennsylvania were carried out by Charles P. Swann at the Bartol Research Institute, University of Delaware.

Naipes do not have raised flanges, but their edges are deliberately thickened (1.7x in a Huaca Menor specimen; 1.6x in the Vicus specimen) to improve rigidity of the thin sheet (see Fig. 45). None of them bears any surface striations, and they are not axe-shaped. Various observers have described them as double T shape (Shimada 1985a) or as I shape (Bennett 1939; Prümers n.d.), and one might see them as ├─┤ shape, depending upon their orientation. Pedersen has perhaps done us a disservice by referring to *naipes* as *"doble hachas monedas"* (1976: 64), Shimada somewhat echoing that description in calling them double T shape. Shimada argues further that "double-T shaped specimens similar to those [*naipes*] found in Batán Grande . . . also occur, though less frequently" in Ecuador (Shimada 1985a: 388 and fig. 16.7). He is referring to one of the "aberrant" Ecuadorian forms Holm published in 1966/67 (fig. 3, right-hand portion) and which we term a "hide" (see Fig. 3b). These objects (Figs. 20, 21), one of which is heavily marked with surface striations, not only do not resemble *naipes,* they are not "double-T" in shape and are unlike any known Ecuadorian axe either in metal or in stone. As Holm remarked, "a suggestion of a double axe is. . . out of place in Ecuadorian archaeology" (1966/67: 139). In fact, we have no precedent for the *naipe* form. Whereas the *naipe* may prove to have been the forerunner of the Ecuadorian *hacha-moneda* in terms of the thin smithing style which both object types share, they were not prototypes in the formal sense.

Relatives: Feathers

Bennett's excavations at Lambayeque One yielded another kind of object we include in our category of relatives: "Three bundles of thin copper leaves wrapped together . . . One such bundle is composed of leaves 15 centimeters long, 3.5 centimeters wide at one end and tapering to 2.0 centimeters wide at the other end. The bundle of these thin leaves is 1.8 centimeters thick. All bundles show traces of the string or cloth used to wrap them" (Bennett 1939: 105). Although these stacked, packeted, and tied leaves are now entirely mineralized, Lechtman was permitted to examine

and photograph them at the American Museum of Natural History and to analyze nondestructively the surfaces of a few of the stronger specimens using x-ray fluorescence techniques. Figure 16 illustrates several of the sturdier bundle fragments excavated by Bennett, with bits of cloth still adhering to some. A profile view of two bundles (Fig. 17) shows not only the stacking of the thin leaves but also the binding of groups of leaves into packets with rather wide ribbon-like ties of reed. Lechtman was able to count ten leaves tied together in each of three packets. From the drawings in Bennett's field notebook, the intact individual leaves resembled the objects illustrated here in Figure 18 (to the right of the scale), collected by Henry Reichlen at the site of "Batanes," near Chongoyape, in the Lambayeque valley (H. Reichlen, personal communication, 1976).[8]

Brüning called this object type "plumiforme" (Antze 1930: 24 and fig. 2) and found at least more than 100 in the Lambayeque valley area. According to Antze (1930: 24), such feather forms made of thin copper sheet were used as headdress ornaments and are common finds. He describes a set of five from Cerro Sapame as measuring approximately 2.5 cm in length, considerably shorter than those found by Bennett and by Reichlen, and he speculates that they were arranged together as hair ribbons (*huinchas*) or perhaps were set into circular metal headbands or on a type of helmet (Antze 1930: 24). During a visit in 1970 to the Museo Arqueológico Brüning, Lambayeque, Lechtman noted hundreds of such thin feather forms in the storeroom, and Mayer, who recently photographed some of them there (see Fig. 8), describes the museum as having "a chest with a volume of about three cubic meters full of these items, often corroded together in groups" (Mayer 1982a: 289; translation by Lechtman). He reports having seen them in the hundreds in other collections on the Peruvian north coast as well.

There are two basic types of feather, one with a spatulate end (Figs. 9, 18), the other with a socketed end (Figs. 9, 18, 19) formed by turning over two edge flaps of metal. The Lambayeque One, Cerro Sapame, and Batanes feathers are of the spatulate type, though of different sizes.

In a burial Alva recently excavated in the Batan Grande area and which he dates to A.D. 850–1100 (Middle Sican) were the remains of long and thin leaves of copper, approximately 40 cm in length, which were originally intact in bundles of "channel-shaped" ("*de corte acanalado*") cross section (Alva 1985: 415–418 and fig. 6). It is impossible to discern the form from the published photograph, but Mayer, who saw the material, describes it as similar to the long feather forms he saw in Lambayeque (Eugen Mayer, personal communication, 1987). Aside from pottery, other grave items included a copper mask of typical Sican style, a copper knife, several beads in the form of gilt copper tweezers, and beads of shell and "turquoise" (Alva 1985). The only other excavated sheet copper feather form material we are aware of from Peru issued from a burial Disselhoff uncovered on the north coast at San Jose de Moro, Jequetepeque valley, Province of Pacasmayo. "At the right shoulder of the skeleton lay a bundle of millimeter-thick copper leaves in the form of half tubes [*halbierter Rohre*] (Abb. 6). He held a tumi of the same metal in his right hand and a copper knife . . . in the left" (Disselhoff 1958: 186; translation by Lechtman). Unlike Bennett, Disselhoff gives us no careful description of these objects, but it seems clear that they are feathers or are related to feathers. The pottery found in the burial he calls "Lambayeque Style." From the published illustrations, it clearly belongs to the Middle Sican presence in the Lambayeque valley, putting the date of this grave somewhere between A.D. 900 and 1150 (Shimada 1985a). This fits well with Shimada's suggestion that some time during Cajamarca Phases III/IV–V there was a Cajamarca colony at San Jose de Moro

[8]In September 1976 Henry Reichlen donated to Heather Lechtman's Laboratory for Research on Archaeological Materials at MIT a large collection of metal objects and associated metallurgical production materials that he had assembled on site surveys along the north coast of Peru. Approximately equal numbers of artifacts were from sites he designated as "Vicus (Piura)" and "Batanes (Lambayeque)." Reichlen's notes accompanying the Batanes collection read as follows: "Documents de l'atelier de métallurgistes Chimu de Batanes, près de Chongoyape (Lambayeque)." It seems clear that Reichlen's site "Batanes" is one of the Lambayeque valley metallurgical production sites similar to those Shimada has identified in the general vicinity of Batan Grande.

that coexisted with a Middle Sican and perhaps a Late Sican colony there (Shimada 1985a: 380).

We would be surprised if the opulent tomb at the Huaca Menor, Batan Grande, contained no feathers. Pedersen reports finding one in the looter's backdirt, and there must have been many more. Though he does not illustrate it, his description is detailed and fits the artifact class closely:

> "Feather" of a helmet or diadem (deteriorated): Consists of a band 11 mm wide at its upper end and 30 mm wide at the base, hammered in the shape of a half cane 260 mm long by 0.5 mm in thickness, missing the part that corresponds to the end that joins [the helmet or diadem]. (Pedersen 1976: 64; translation by Lechtman)

Pedersen's sense of the general shape of this "copper" object as resembling that of half a cane ("*media caña*") is almost identical with that of Disselhoff's half a tube; the length of the Huaca Menor example is almost twice that of the feathers excavated by Bennett.

In Ecuador, Meggers, Evans, and Estrada excavated a group of 130 loose feathers of the socket-end type, several of which we reproduce in Figures 18 and 19, that are virtually identical to the Peruvian feathers of that same type which Mayer photographed at the Brüning Museum: compare Figures 8 and 18 (Meggers et al. n.d.). They may even have been imported from the south. The feathers come from an exceedingly rich multiple urn Milagro-Quevedo burial which the excavators have called the "Cacique Guayas" burial. The site, La Compañia in Los Rios Province, is an Integration period (ca. A.D. 850–1532) cemetery, but the presence there of these socketed feathers may indicate a date for the Cacique's tomb as falling within the first half of that span of time.

It is evident why we include feathers as relatives of axe-monies and of *naipes*. They are made of very thin sheet metal (spatulate feather collected by H. Reichlen at Batanes: θ_{av} = 0.045 cm; Cacique Guayas socketed feather: θ = 0.014 cm) with thickened edges; they are burial items often found in large numbers and frequently stacked, packeted, and tied; they are made of copper-arsenic bronze. The Batanes feather contains 1.98% arsenic; the Cacique Guayas feather contains 5.2% arsenic; the Lambayeque One feathers, which are totally mineralized, contain 2.6% arsenic at the surface where the arsenic is a constituent of the non-metallic copper-arsenic corrosion products (see Table 2). In short, they share many of the features of thin-style smithing that are the hallmark of the large majority of objects discussed here. In addition, metal plumes worn as headdress ornaments were a distinct sign of elite status not only among Sican lords and Chimu kings but, according to Salomon (1987: 221), also among native peoples of Ecuador in the sixteenth century, who wore them as symbols of high political rank.

Relatives: "Hides" and Insignia

Holm (1966/67), in his earliest publication of the Ecuadorian material, singled out three "aberrant" or atypical forms of axe-money. One of those is the *naipe*. We continue to include the other two in the category of relatives, though their relation to axe-monies is not clear. The first type, illustrated in Figures 3b, 20, and 21, we tentatively designate a "hide." As Holm has noted (1980: 58), it is reminiscent in form of the flayed, stretched, and dried skin of a four-legged animal, and departs considerably from any known Ecuadorian axe shape (Holm 1966/67: 138). The second type, insignia (Figs. 3b and 22), resembles the anthropomorphized *clava de insignia* or *bastón de mando,* a relatively common artifact type in the Milagro-Quevedo inventory of metal manufactures (see, e.g., E. Estrada 1957: figs. 59, 60). Holm considered the presence of a raised edge flange on both these artifact types as well as their manufacture from thin plate, their flatness, and their clear distance from service as implements of any kind as sufficient traits for inclusion in his larger category of axe-monies. They are also considerably larger and much rarer than the normal type and, he speculated, possibly represented greater intrinsic wealth (Holm 1980: 58).

We are aware of only seven examples of "hides": three in the collection of the Museo Antropológico, Banco Central del Ecuador in Guayaquil, three in the Museo de la Municipalidad de Guayaquil, and one in a private collection in that city. Two of the Museo Antropológico pieces have no exact

provenience; they were collected in Manabi. The other five are from a "shaft-and-chamber burial near the village of Manglaralto, in the area of the Manteño culture" (Holm 1966/67: 138). Only the three Museo Antropológico objects were available to us for study. One is almost identical in shape, size, and surface characteristics to its mate, shown in Figure 20. The third has the slightly different contour presented by the "hide" in Figure 21, but its surface is almost smooth. Each of these three pieces has at most a few irregular marks on one or both surfaces made by indenting the metal under the blow of a tool (see Fig. 20). The marks are randomly oriented and do not resemble the striations found on the standard axe-money. They are tool marks made during shaping of the metal plate. On the other hand, the "hide" shown in Figure 21, published by Holm in 1966/67 (fig. 3, object at lower right), has many striations or grooves running parallel to the horizontal axis of the piece and a few that run perpendicular to these, but only along one edge (along the right vertical edge in the photograph). As this object was not available for study, we cannot comment in detail on the manner in which the striations were made—Holm reported in 1966/67 (p. 138) that they are "hammered grooves"—nor on the material of manufacture. All three of the Museo Antropológico pieces have been analyzed and are made of copper-arsenic bronze (see Table 2). All three have a raised flange that runs around the *entire* perimeter of the object. They are also close in size. In relation to the orientation given in Figure 3b, dimensional ranges are: height, 11.0–12.6 cm; width, 9.2–10.2 cm; average thickness of the plate, 0.21 cm; average weight, 109.4 g.

In spite of the fact that these objects are so different in form from any Ecuadorian axes and have a raised flange on all edges, including the edge which might represent the working blade, the distribution of the pronounced grooves on the surface of one of the Manglaralto examples (Fig. 21) warrants careful consideration. Their orientation is like those on standard axe-monies: the majority run parallel to the edges of the "shank," while a few run perpendicular to these, across the "blade." Although this distribution does not mandate that the object which bears these striations represents an axe, we know of no artifacts, other than axe-monies, so imprinted. At the same time, there are features of these parallel impressions that are not characteristic of the standard axe-money form. The horizontal grooves cover virtually the entire surface of the object, extending into the "ears" or lobes of the piece, both at the "butt" end (Fig. 21 left) and at the "blade" end (Fig. 21 right). From inspection of the photograph alone, it appears that the horizontal grooves were originally made across almost the entire surface of a roughly rectangular, hammered plate of metal whose area is given approximately by the outer dimensions of the finished piece. The -shaped upper and lower contours may then have been achieved by cutting away portions of the rectangle, thereby removing the middles of some striations but leaving their ends. Those ends are clearly visible at two of the four ears or lobes. Finally the flanges were upset and the vertical striations added along one edge. Although we cannot verify this interpretation through examination of the object, such a sequence of steps would account for the configuration of the surface grooves as we see them. The form of this object—including its continuous perimetrical flange, the proposed manufacturing technique, and the distribution of surface striations—departs considerably from the standard treatment given axe-monies. Yet it and the others in its group have a fit that is hard to deny. Thus they stand as relatives.

Axes that are closest in form to these hide-shaped objects tend to be Inkaic in origin. Some are common to the central Andes, others to southern Ecuador and northwest Argentina. None is identical to the hides, but all have the deep contour that runs from the butt along the shank to the shoulder of the blade. Mayer (1986) illustrates several from the Provinces of Catamarca and Jujuy in Northwest Argentina. Some of these have a somewhat triangular blade, rather like the heavily grooved Manglaralto hide (Mayer 1986: pl. 16.306); some have flat or even somewhat circular blades (Mayer 1986: pl. 17.315, 17.316). They are all likely to be tin bronzes. Holm disclaims any close relation between the hides and Inka axes: "What simulates the hafting ears at the poll of these two . . . money-axes [shown here in

Figs. 20 and 21] are quite alien to Ecuadorian copper axes of any kind, and they are, if anything, slightly reminiscent of the Inca copper axe. However, Inca money-axes are unknown, and the Inca influence never left any cultural vestiges on the coast land of Ecuador, even if the latest military expansion was contemporaneous with the Manteño and Milagro-Quevedo Cultures of the Integration Period . . ." (Holm 1966/67: 138).

We do not insist that the shapes of these unusual objects represent animal hides. If they do, we suggest that the animal may have been a camelid, more specifically the llama. Beatriz Ventura recently published (1985) the results of her archaeological and metallurgical research on an interesting group of copper alloy objects from burials at two sites in the *selva occidental* of northwest Argentina, Manuel Elordi and El Talar. Both are almost at the present border with Bolivia, Manuel Elordi in the Department of Oran (Salta), at the confluence of the San Francisco and Bermejo rivers, and El Talar in the Department of Santa Barbara (Jujuy), slightly farther south along the Rio San Francisco. Both sites belong to the same culture area and are contemporary. A single radiocarbon age obtained from human bone excavated at Manuel Elordi provides a date of 1030 ± 120 BP (Ventura 1985: 7), or about A.D. 955. Accompanying the metal objects in the tombs were ceramics and small beads of sodalite, turquoise, and chrysocolla; a few textiles were found only at El Talar.

All the metal objects were interred inside ceramic urns. They include wide arm bands ("*brazaletes*"); narrow wrist bracelets; open rings; "*llamitas*" of sheet metal; star-shaped, perforated metal objects thought to be small bells ("*campanitas*") (these are identical to objects found abundantly on the north and central coasts of Peru, made of copper-silver alloy; see Lechtman 1973: fig. 20); a few needles and depilatory tweezers; and a variety of zoomorphic forms, perhaps pendants, also made of sheet metal (Ventura 1985: 9–13). Qualitative analysis of the composition of thirty-two objects was carried out, with subsequent quantitative determination of ten representative pieces from among them (one object was a sheet metal "*llamita*" of gold-silver-copper alloy, with the typical composition of coastal Peruvian ternary alloys of this class: 87% gold, 10% silver, 3% copper; Ventura 1985: 87). The large majority of the material from both sites is made of copper-tin bronze with some pieces containing as much as 21–24 weight percent tin. The average tin concentration in objects from both sites is about 13.3%, with a wide variation of from 2 to 24% (Ventura 1985: 22–23). Ventura attributes the manufacture of all of these metal burial offerings to highland peoples in the Andes of nearby southern Bolivia. Given the radiocarbon date, the alloy type, and associations with other materials from the northwest Argentina-southern Bolivia region, she places these sites in a Late period context (1985: 17–20), that is, from about A.D. 850 to 1480 (González 1979).

Of interest to the discussion here are the tin bronze "*llamitas*" and associated zoomorphic forms, some of which are reproduced in Figure 23 (Ventura 1985: figs. 2 and 3). The "*llamitas*"—those sheet metal shapes that are llama-like in appearance—occur in a wide variety of forms and sizes at both sites. Only a few of these are reproduced in Figure 23. Lengths range from 2.5 to 7 cm; widths from 1.9 to 3.5 cm; sheet thickness from 0.05 to 0.3 cm. Many of these objects have a suspension hole high up along the back of the animal. The quantitative analysis of only one of these llamas is reported; it is an alloy of 93% copper, 7% tin (Ventura 1985: table 5).

Associated with the "*llamitas*" is a series of zoomorphic forms, some of which bear close relation to the camelid pieces, as is evident from Figure 23. Commenting upon Forms A and B, Ventura suggests that "with the addition of a pair of small notches, these forms could be transformed into '*llamitas*,' forms which also have one or two suspension holes" (Ventura 1985: 12; translation by Lechtman). All of these zoomorphic-shaped sheets are made from tin bronze; one Form B piece was analyzed as containing 87% copper and 13% tin. The Form D objects are interesting especially for their increased stylization and their large range in sizes and in weight. Nevertheless, their prototype in the "*llamita*" seems likely. Some are as large as 11 cm in length, and the heaviest, 0.4 cm thick, weighs 150.1 g; the average weight

of this group is 72.6 g (Ventura 1985: 13). Form D objects have from one to three suspension holes. Ventura suggests they were either sewn onto clothing or worn as pectorals (1985: 13).

Another group of copper or copper-alloy objects found in northwest Argentina and in central and north-central Chile is reminiscent of the stylized llamas Ventura describes from the southern Bolivian highlands. We illustrate one of three examples (Fig. 24) excavated at the prehistoric cemetery of Coquimbo (Castillo, Biskupović, and Cobo 1986; Museo Chileno 1986: no. 166), on the north central Chilean coast (the Norte Verde). Several are also known from San Pedro de Atacama, in the desert of northern Chile (Mayer 1986; Lechtman, field notes, 1987), and quite a few have been reported from the Provinces of Catamarca, Jujuy, and Salta in northwest Argentina (Mayer 1986). Those that have been excavated are grave goods. Their function is unknown, but each of two of the three excavated at Coquimbo was found loosely tied to the forearm of a human skeleton (Castillo, Biskupović, and Cobo 1986).

The Coquimbo cemetery represents the end of the Las Animas cultural complex or the first phase of the Chilean Diaguita culture (Diaguita 1) on the coast, with a date somewhere between A.D. 800 and 1200 (Museo Chileno 1986). Of 28 graves excavated, only eight did not contain camelid burials; all others had from one to five camelids placed in intimate association with a human skeleton. Many of the graves also contained small "*campanillas,*" identical with the bells from Manuel Elordi and El Talar. Las Animas communities were heavily oriented toward pastoralism, and "a distinguishing trait of this complex is a complicated funeral ceremony involving the sacrifice of llamas. These were probably buried with their owners as an expression of an intimate relationship since in the graves located at the Plaza de Coquimbo llamas were found embracing the deceased with their forelegs. . ." (Museo Chileno 1986: 24). Although the metal plates in question are associated with llama herders, there is no assurance that their form represents that of a camelid. It is suggestive of that form, however, even as the form is known from ceramics of the prior El Molle complex on the Chilean coast (see, e.g., Cornely 1956: 188, fig. 14).

This excursion south is useful because it provides at least one alternative to the question of what certain relatives—hides and possibly *naipes*—may have represented, if not axes. Perhaps their models were llamas. We do not suggest that hides or *naipes* look precisely like Bolivian "*llamitas*" or Las Animas plates, nor that such forms somehow made their way direct from Chile and Argentina to Ecuador, for which there is certainly no evidence. In fact, the plates are not flat. They fold over along the two long vertical sides (see Fig. 24 right), providing each with a narrow lateral strip outfitted with holes for attachment to some other unit or material. And the "*llamitas*" are not stretched hides; they are views of the animal from one side. Nevertheless, the similarities are there, and it may be that the currency of such forms during the period with which we are concerned encouraged parallel responses. Certainly llama offerings are associated with the burials that contain axe-monies at Ayalan, in Ecuador (Ubelaker 1981), and Shimada reports (1987b: 20) that camelid fetuses were sacrificially offered in elaborate rituals before the onset of construction and use of the earliest Middle Sican smelting furnaces at the site of Huaca del Pueblo, Batan Grande.

We can contribute little that is new to Holm's (1966/67) original evaluation of the *bastón* or insignia relative. The example illustrated in Figure 22 shows the location of the raised flange, which is confined to the circular end of the object, stopping just below the two lateral indentations. The metal plate, hammered to shape, ranges in thickness from 0.18 to 0.29 cm at the circular end; the raised flange there measures 0.49 cm at its thickest. Though heavier than any of the other objects described here (228.1 g), this piece is considerably lighter than the cast, anthropomorphized insignia that are its prototypes. Surface analysis by x-ray fluorescence shows the metal to be a copper-arsenic bronze containing 1.10% of the alloying element. We know of only two examples of these objects, neither of which has surface decoration or striations. Because of their rarity we have not sampled them for metallographic study.

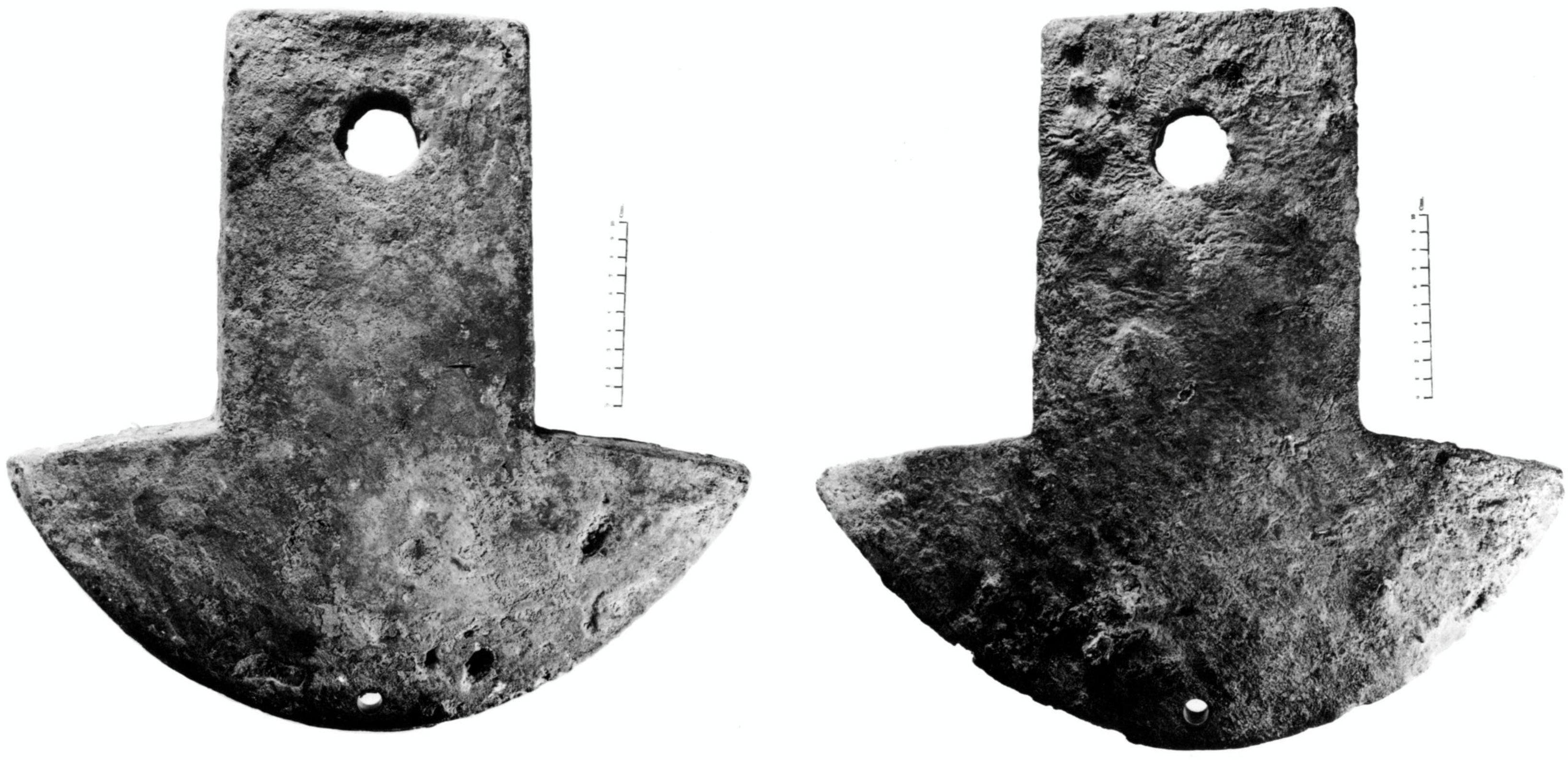


Fig. 10 Giant cast axe, Manabi, Ecuador. This axe and three others like it were cast in open moulds. Left: view of the lower surface of the axe that was in contact with the mould during solidification of the metal. Right: view of the porous, bubbly upper surface exposed to the environment during solidification. The hole near the blade edge locates a core-drill sample removed from the object for chemical and metallographic analyses. Collection: Museo de Arte Prehistórico de la Casa de la Cultura, Guayaquil, Ecuador (MAP 2.C.C.N.G.; MIT 3483).

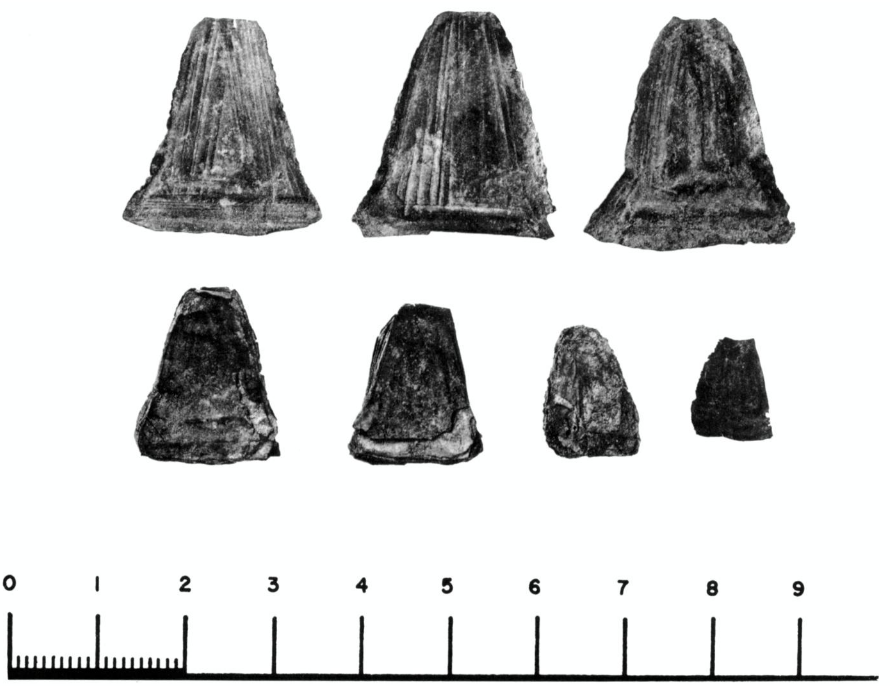


Fig. 11 A group of Type 1b axe-monies from Babahoyo, Ecuador. Those in the top row are individual leaves. The hammered striations are sharp and crisp as is the chisel-cut outline of the edges of the leaves. The smaller items in the bottom row are packets of leaves except for the single axe-money at the far right, the tiniest example encountered to date. Collection: Museo Antropológico del Banco Central del Ecuador, Guayaquil, Ecuador.

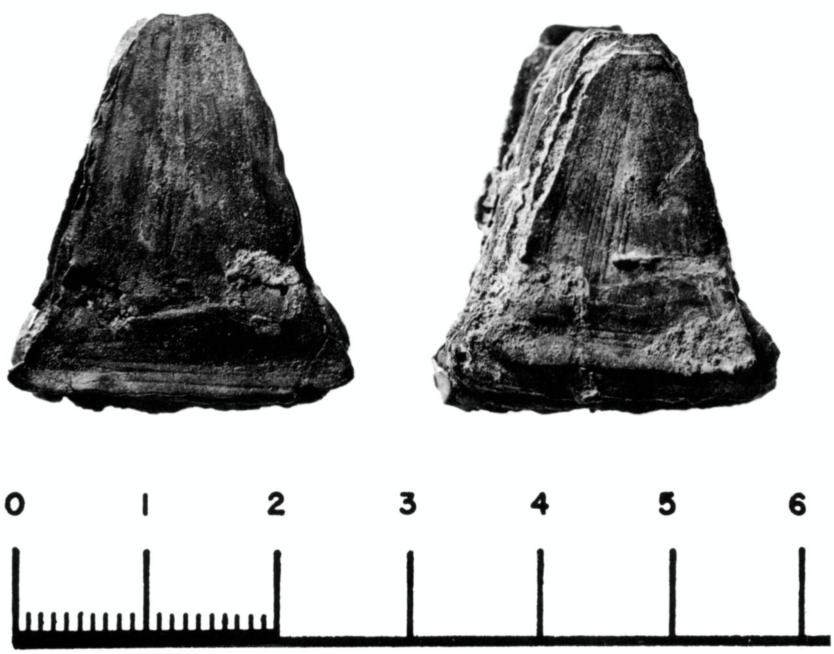


Fig. 12 Two packets of Type 1b axe-monies from the site of Churute, Ecuador. Remnants of the string that tied together the leaves of the packet at the right are still visible on the surface. Note the sharp vertical and horizontal striations. Collection: Museo Antropológico del Banco Central del Ecuador, Guayaquil, Ecuador (MIT 3463).

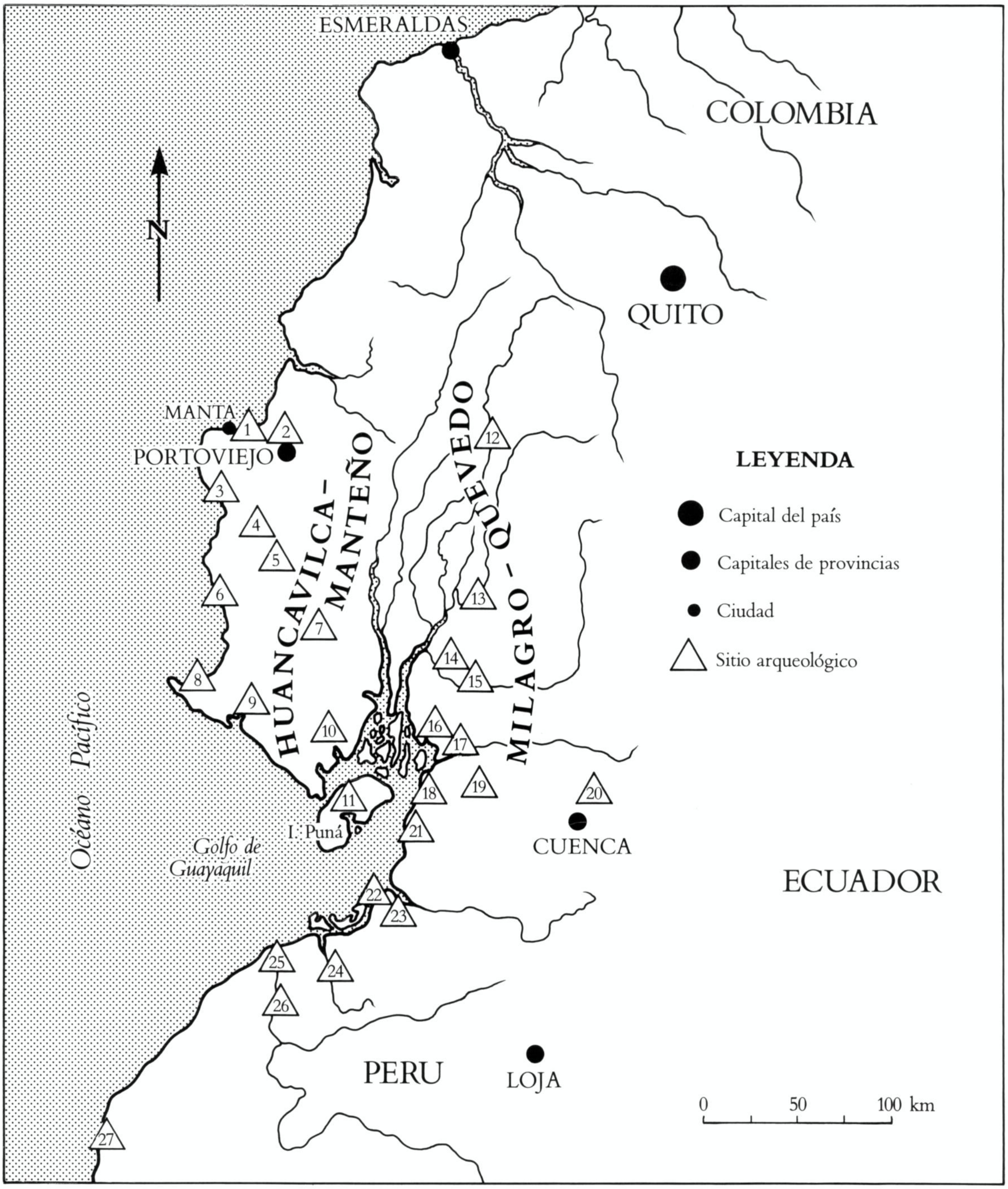


Fig. 13 Map of the north Andean coastal zone, including Ecuador and the extreme north coast of Peru. The sites where axe-monies have been found fall within the Milagro-Quevedo and Huancavilca-Manteño culture areas. 1. Jaramijo 2. Cerro Jaboncillo 3. El Barro 4. Plagosa 5. Pedro Pablo Gomez 6. Manglaralto; Olon 7. Cerro de Paco 8. La Libertad; Salinas 9. Cangrejito 10. Ayalan (Anllulla) 11. Puna 12. Quevedo; San Camilo 13. Babahoyo 14. Milagro 15. Las Palmas 16. Churute 17. Hda. Los Alamos 18. Balao Chico 19. Hda. El Retiro 20. Guapan 21. Balao 22. Machala 23. Cambio del Guabo 24. Arenillas 25. Tumbes (Peru) 26. Garbanzal (Peru) 27. Talara (Peru).

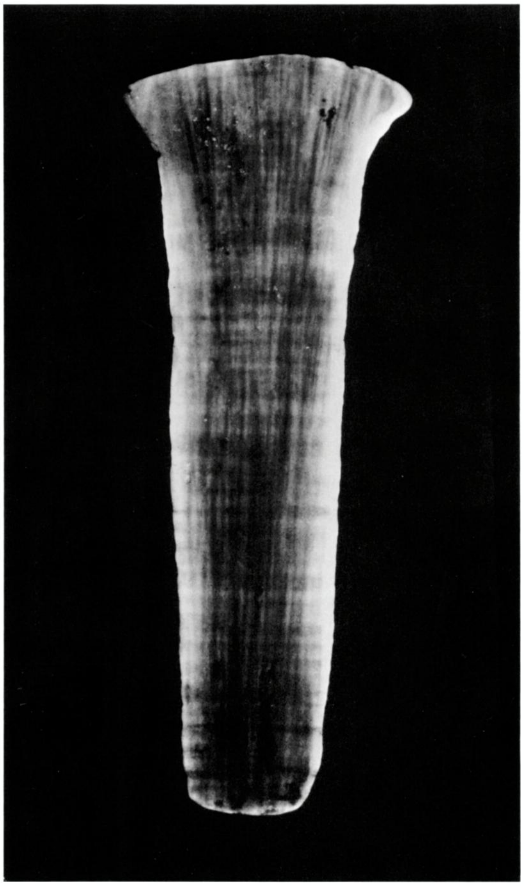


Fig. 14 X-radiograph of the West Mexican (Guerrero) Type 1a axe-money illustrated in Figure 6. Light areas correspond to thicker metal, dark areas to metal that is thinner. The narrow light and dark parallel bands that run the length of the object represent alternations in metal thickness that provide the object with a corrugated structure. This, in conjunction with the thickened edge all around the perimeter of the axe-money, strengthens the thin sheet.

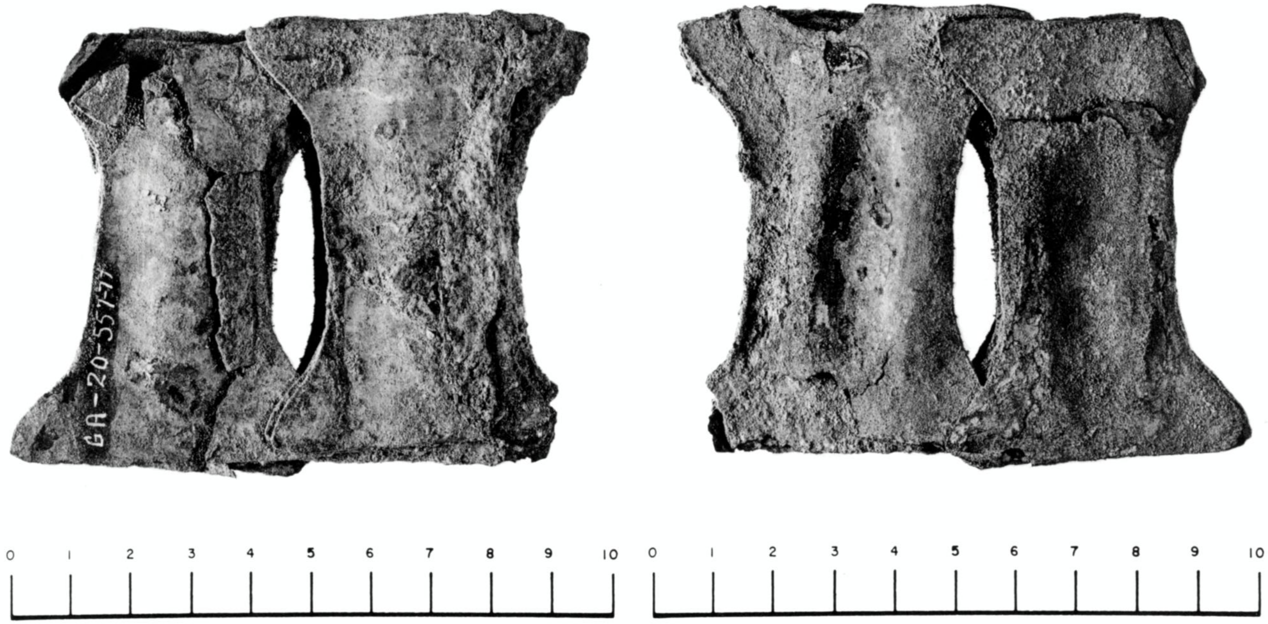


Fig. 15 Packet of *naipes* from the Huaca Menor, Batan Grande, Lambayeque valley, Peru. The packet consists of two groups of *naipes*, each containing several stacked leaves. The groups are interlocked in a manner typical of the *naipes* found in the Huaca Menor tomb, and the packet may originally have contained additional interlocked sets. These *naipes* exhibit a central oblong "bubble" seen as a convexity in the photo at the left and as a concavity in the photo at the right. Collection: Gift of Asbjörn Pedersen to Olaf Holm; presently in the collections of the Museo Antropológico del Banco Central del Ecuador, Guayaquil, Ecuador (MIT 3451).

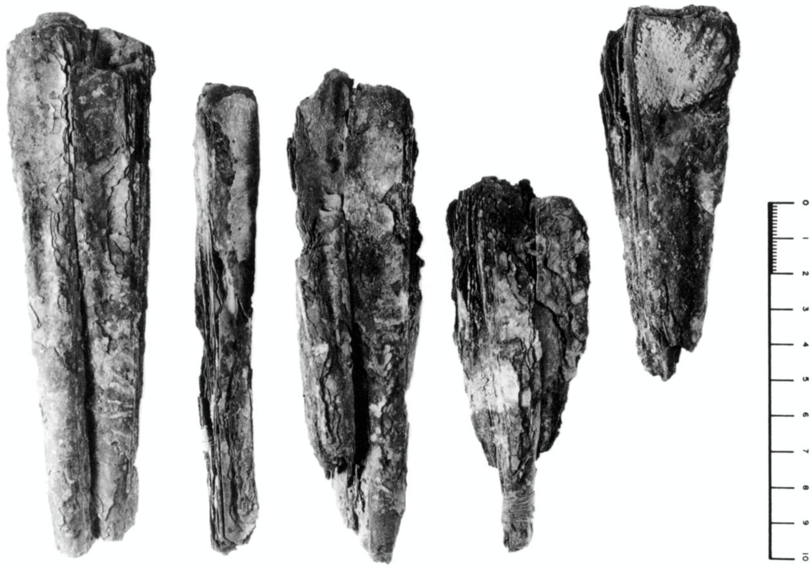


Fig. 16 Bundles of feathers excavated by Wendell Bennett at the site Lambayeque One, Lambayeque valley, Peru. Individual leaves are entirely mineralized and some of the bundles are fragmentary, but the feather shape is recognizable. The bundle at the far left contains two packets of feathers; the bundle fourth from the left contains three. A remnant of woven cloth clings to the surface of the packet at the far right. Collection: American Museum of Natural History, New York (AMNH 41.1/436; MIT 3492).

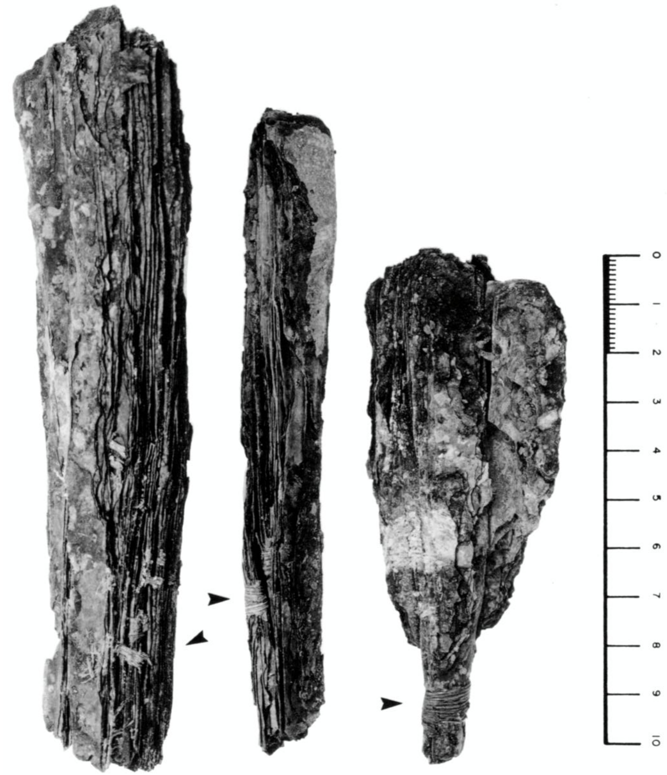


Fig. 17 Several of the feather bundles shown in Figure 16 have been rotated to permit a partial profile view of the stacked configuration of individual leaves within the bundle. Groups of 10 leaves are bound into packets with reed ties (see arrows in photo), and the packets are stacked into bundles.

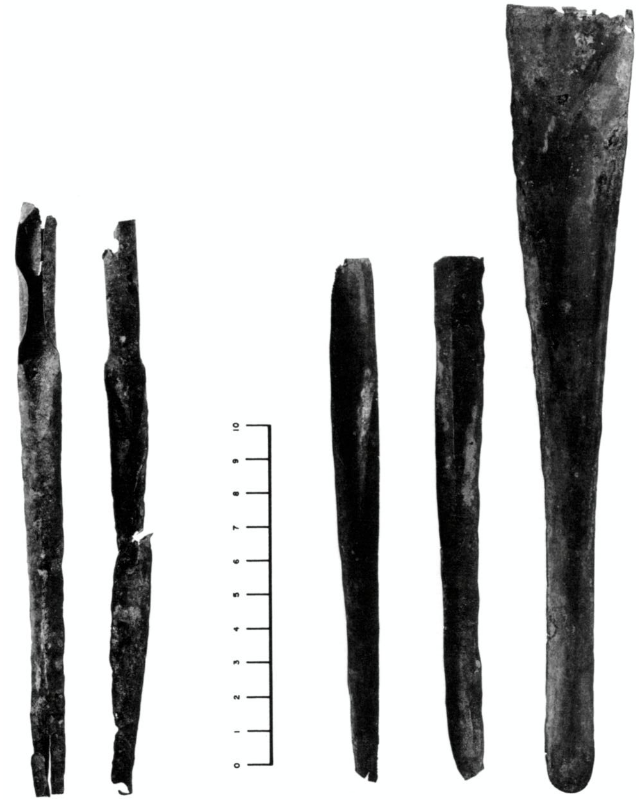


Fig. 18 Feathers from Ecuador (left of scale) and Peru (right of scale). The Ecuadorian examples, of the socket-end type, were part of the sumptuous burial offerings of the so-called Cacique Guayas tomb at the site of La Compañia, Los Rios Province. The Peruvian feathers, of the spatulate-end variety, were collected by Henry Reichlen at the site of "Batanes," Lambayeque valley. Collection: Ecuador—Museo Antropológico del Banco Central del Ecuador, Guayaquil (GA 285.914.78; MIT 3485, 3486); Peru—Gift of Henry Reichlen to the Laboratory for Research on Archaeological Materials, MIT (MIT 3487, 3490).

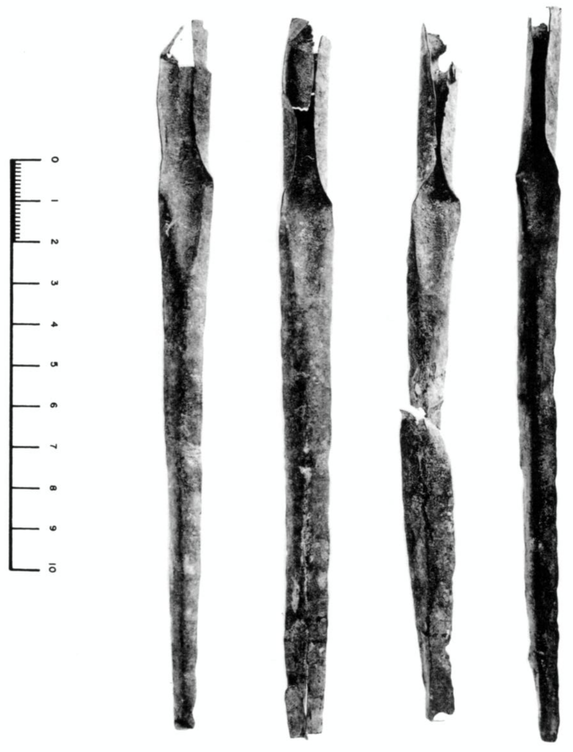


Fig 19 Socket-end feathers from a group of 130 that formed part of the Cacique Guayas urn burial excavated by Meggers, Evans, and Estrada at the site of La Compañia, Los Rios Province, Ecuador. These feathers are virtually identical to two of the feathers from the Lambayeque valley shown at the far left in Figure 9. The Ecuadorian feathers may have been made in the Lambayeque valley region. Collection: Museo Antropológico del Banco Central del Ecuador, Guayaquil, Ecuador (GA 285.914.78; MIT 3442, 3443, 3485, 3486).

Fig. 20 "Hide" from a shaft-and-chamber burial near the village of Manglaralto, Guayas Province, Ecuador. The irregular marks on the surface are from the blows of a tool used in shaping the metal plate. The object has a raised flange along its entire perimeter. Collection: Museo Antropológico del Banco Central del Ecuador, Guayaquil (GA 120.127.76; MIT 3449).

Fig. 21 "Hide" with surface striations, from the same Manglaralto burial as the example shown in Figure 20. The hammered grooves are considerably wider and deeper than the fine striations characteristic of most Ecuadorian axe-monies (compare Figs. 2 and 39). Not all "hides" of this shape exhibit surface striations. The original photograph of this object (Holm 1966/67; fig. 3) was severely damaged in the 1983 El Niño floods in Guayaquil. Figure 21 is a photograph taken of the original print after superficial conservation treatment. Collection: private collection, Guayaquil, Ecuador (MIT 3537).

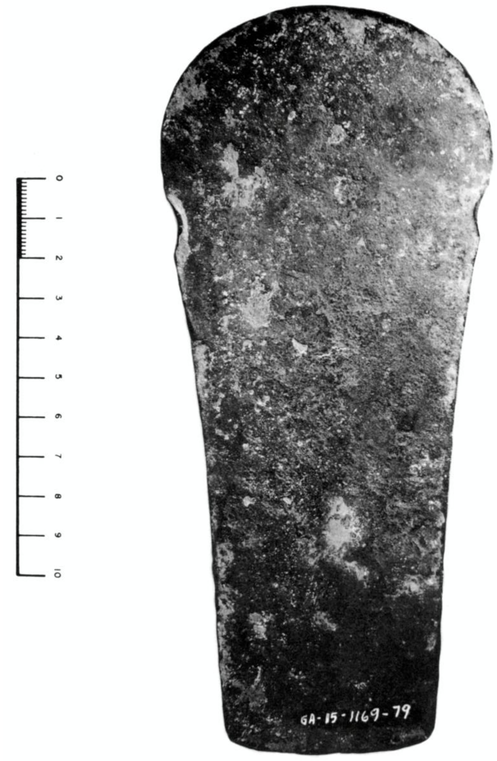


Fig. 22 *Bastón de Insignia* from the region near Milagro, Guayas Province, Ecuador. The raised flange around the circular upper portion of the plate extends somewhat below the curved indentations at either side. Collection: Museo Antropológico del Banco Central del Ecuador, Guayaquil (GA 15.1169.79; MIT 3450).

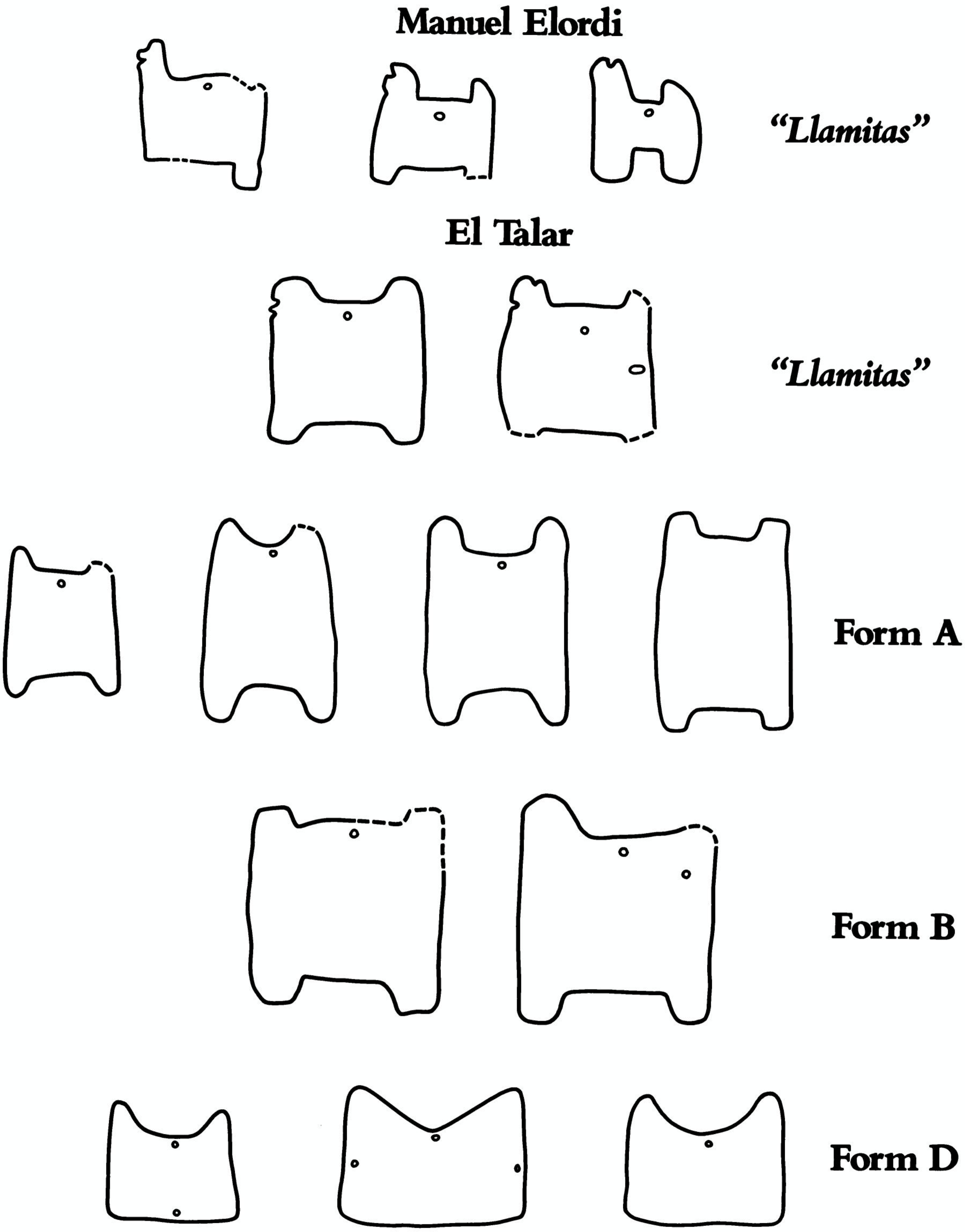


Fig. 23 "*Llamitas*" and associated zoomorphic forms made of tin bronze sheet metal excavated from burials at the sites of Manuel Elordi and El Talar in the *selva occidental* of Northwest Argentina. Drawings after Beatriz Ventura 1985: figs. 2, 3.

Fig. 24 Object of unknown use whose form is reminiscent of a llama. This example, tied to the forearm of a skeleton, was excavated at the cemetery of Coquimbo, on the north central coast of Chile. The metal composition has not yet been determined. Height: 15.5 cm. Width: 7.7 cm. Weight: 163.5 g. Photograph by Fernando Maldonado. Collection: Museo Arqueológico de la Serena, La Serena, Chile.

Were They Axes and Were They Monies?

The archaeological evidence is abundantly clear that axe-monies and relatives were burial paraphernalia, at least in Ecuador and Peru, and that throughout the Americas they were often hoarded in large numbers. Prümers (n.d.) points out that their grouping in standard sets (by size and by number in a given packet) may have had religious import and that, in any case, the ritual significance of the "bundle" is well established, especially in burial practice in Peru where objects of all kinds and of many materials were tied and/or wrapped in cloth upon interment. He concludes that Ecuadorian and Peruvian "axe-monies" are to be interpreted purely as grave goods whose deposition in the grave was part of the burial rite; their quantity in a grave reflects the social status of the buried person (Prümers n.d.). Prümers would also include in the general category *hacha-moneda* other small sheet-metal objects that have been tied into a packet, regardless of their shape, number, or the metal of which they are made, such as a package of ten thin, silver leaves shaped like an arrow-point and bound with cotton thread from the site of El Castillo, Huarmey valley (n.d.: fig. 7 and Fig. 8); or a package of two little copper sheet metal items, tied with cotton thread, from Venturosa Alta, Supe valley, Peru (n.d.: fig. 8). Both finds are associated with Middle Horizon ceramics. We should point out, however, that the binding, bundling, and burial offering of small cakes of cast copper or of bits of sheet metal, sometimes folded fragments of sheet, at other times completely shaped pieces such as those Prümers describes, is a funerary tradition of great chronological depth along the central Andean coast. We observe it at least as early as Moche times on the Peruvian north coast, and it continues into the Late Horizon. Lechtman has studied a variety of such sheet metal items from sites as far south as the Ica valley; they are made of copper, silver, and gold as well as the alloys of these metals. They seem to bear little relation to the axe-money phenomenon we are examining here except that they underscore the cultural value of metal of all kinds, even sheet metal scraps which may have served as amulets.

Ethnohistoric sources and the internal evidence provided by the objects themselves allow us to focus on their use in life, not only their use at death.[9]

[9]In our treatment of axe-monies we have not attempted to discuss these objects within a more general analytical and comparative context that examines them as instances of "primitive money." Except in the case of the Mexican material, for which there is solid ethnohistoric evidence for the simultaneous use not only of *hachuelas* but also of *mantas,* cacao beans, and other items as standards in exchange, such an effort would be exceedingly difficult. Holm (1978) pointed out that, with respect to a set of attributes we generally ascribe to modern Western money (these are listed in Einzig 1949 but were formulated originally by Jevons in 1875), Ecuadorian axe-monies exhibit a subset of these: they are portable, recognizable (with flanges and surface striations), and have inherent value (buried in large numbers). As these are the three core attributes Einzig specifies as necessary for items to function as "primitive money," Holm acceded to that designation for the Ecuadorian corpus. He noted, however, that the main difference between primitive and modern money lies not in individual attributes, many of which are shared by both, but in their functions: modern money is polyvalent, or all-purpose; primitive money is univalent, restricted in value and in circulation. In fact, primitive money generally refers to a constellation of several quite different monies—such as *hachuelas, mantas,* and cacao beans—which function in independent transactional spheres. In the Ecuadorian case, axe-monies, emeralds, *chaquira,* and perhaps gilt nose rings constituted such a group of monies, but the context of their use is largely missing (see, however, Salomon 1986).

Money, the origins of the modern general purpose variety, the nature of economies that utilize the primitive variety, and the impact of modern money on such economies is the subject

Mexico

Our richest source of ethnohistoric information about axe-monies comes from Mexico. Objects that are similar to the extremely thin West Mexican variety (Type 1a) are illustrated in the *Codex Mendoza* as tribute items to the Aztec from two tribute provinces of Guerrero: Quiauteopan, which owed 80 "*hachuelas*" a year, and Tepequacuilco (Clark 1938). The *Relaciones Geográficas* from Michoacan report that "*plata tendida muy delgada*" (very thin sheets of silver) was a tribute item to the king of Michoacan (Schöndube n.d.: 200). Although the metal in this case is silver rather than copper, the key idea is that thin, leaflike pieces of metal serve as tribute (Hosler 1986). In Sahagún's illustrations of merchants' wares (Sahagún 1950–1975: 9, pl. 3), two objects which resemble the *hachuelas* depicted in the *Codex Mendoza* as tribute are shown among items carried by the merchants. Thus, though the documentation is sparse, of the few sixteenth-century Spanish sources that refer directly or indirectly to the thin West Mexican axe-money type, all set it in the context of tribute (Hosler 1986). A glimpse of the form and quantity in which copper tribute from West Mexico was rendered is provided by an inventory, drawn up in 1528, of the copper from Michoacan stored in the Casa de Munición (arsenal) in Mexico City (Hosler 1986). The list includes eight hundredweight (368 kg) of copper, 500 copper shields, and 113 cases of copper *hachuelas* (Barrett 1981: 12).

On the other hand, the documents that refer to the curved blade varieties of axe-money (Types 2a and 2b), found chiefly in Oaxaca, describe them as both tribute and money. Fray Toribio de Motolinia states in his *Memoriales* that in parts of Mexico thin T-shaped copper objects were used as currency (Motolinia 1903). The *Relaciones Geográficas* from Oaxaca are particularly telling because they express the relation between currency and tribute (Hosler 1986). They state that "*hachuelas de cobre*" (Paso y Troncoso 1905–1906) were tribute items to Tututepec from the towns of Tetiquipa and Cocautepec. In addition, the *Relación* for Tetiquipa explains that such axes were currency and were circulated and sold in the markets for purposes of tribute:

> . . .no tenian minas conocidas de donde sacar el oro ni otros metales y que las hachas de cobre que solian tributar hera [era] moneda que corria y se vendia en los tianquez y mercados que se hazian en todos los pueblos. (Troike n.d.: 7)

Further insight into the dual role of Oaxacan axe-monies is had from Francisco López Tenorio, Regidor de Antequera (city of Oaxaca), who, in a 1548 letter to the "presidente del consejo de Indias" (Medina 1912: 563) in Spain, includes a line drawing of an axe-money (redrawn here in Fig. 31), closest to our Type 2b, and gives its equivalent value in Spanish reales. The text reads:

> Esta es la forma de moneda de cobre que se usaba en la Nueva España . . . Valian 4 de estas nuevas 5 reales y despues siendo gastadas un poco no las querian recibir en precio alguno y venian a valer 10 por 1 real, para tornarlas a refundir . . . (Medina 1912: 562)

> This is the kind of copper currency [coins] which were used in New Spain . . . When new, 4 of these were worth 5 reales while later, when somewhat worn they would not accept them at any price so they came to be worth 10 to 1 real [at which point] they sent them to be recast. . .(translation by John V. Murra)

of a substantial literature in economic anthropology. As a general study, Jacques Melitz' *Primitive and Modern Money* (1974) is probably the most useful. (Einzig's *Primitive Money in Its Ethnological, Historical and Economic Aspects* (1949) was revised and newly published in 1966.) George Dalton's "Primitive Money" (1965) develops some of the major issues about the institutionalized uses of varieties of money that were originally set out by Polanyi in "The Semantics of Money-Uses" (1968 [1957]). Philip Grierson, in "The Origins of Money" (1978), provides a good historical orientation to the development of modern currency and its relation to primitive money. Some of the richest archaeological and ethnographic research on money and the nonindustrial economies in which it functions or once functioned comes from scholars of African societies. Among many such works we might suggest: Jane I. Guyer, "Indigenous Currencies and the History of Marriage Payments" (1986); Eugenia Herbert, *Red Gold of Africa* (1984); James L. A. Webb, Jr., "Toward the Comparative Study of Money: A Reconsideration of West African Currencies and Neoclassical Monetary Concepts" (1982); Philip Curtin, *Economic Change in Precolonial Africa* (1975); Paul J. Bohannan, "Some Principles of Exchange and Investment among the Tiv" (1955) and "The Impact of Money on an African Subsistence Economy" (1959); George Dalton, "Aboriginal Economies in Stateless Societies" (1977); and the "Introduction" to *Markets in Africa* (1962) by Paul Bohannan and George Dalton. The recent anthology of articles on the kula exchange, edited by Jerry W. Leach and Edmund Leach (1983), contains some excellent discussions of money and exchange. Of particular interest are the articles by Raymond Firth and Chris Gregory.

The Regidor uses the term "*gastada*"—"after they have become slightly worn"—and comments further that money of this kind is current "in very large quantities" (Medina 1912: 563). One has the sense of *hachuelas* being circulated among many hands in the Oaxacan marketplace as a common form of exchange for other goods until they became worn, at which time even the Spaniards could not purchase them for silver reales; they were melted down to provide the stock for new ones. Nowhere does any of these early European commentators refer to any other use of these thin axe-like items. What is so interesting about the Mexican *hachuelas* is that they not only had exchange value in relation to other market goods, but they themselves were a marketable commodity, "purchased" at the same markets to satisfy the tribute quotas.

Note that the Spanish writers use the term *hachuela* to refer to the objects archaeologists call axe-monies (*hachas-monedas*). *Hacha* is the Spanish word for axe; *hachuela* means hatchet. It is clear, however, that, in the contexts of the descriptions cited here, the Europeans use the diminutive *hachuela* exclusively to refer to an axe form used as a medium of exchange and as tribute. The diminutive refers not only to relative size and weight but to the nonutility of the item as a tool: it looks like a hatchet but does not function like one (see also Salomon 1987: 221).

On the other hand, Spaniards may not have observed the use of axe-monies outside of the marketplace and the tribute list. Hosler (1986: 291–343 and figs. 6.1-1 – 6.1-34) undertook a careful chemical and metallographic examination of Types 1a, 2a, and 3a Mexican axe-monies in an effort to discern the relations among their design, physical and mechanical properties, and object function—as standard of value, as tool or implement, or as both. It is obvious from their thinness and slight weight that axe-monies could not have served in any heavy duty capacity, as Easby (1967) and others have observed; but activities such as light cutting, chopping, or scraping seem possible given their shape and heft. The laboratory studies corroborated the impression that the thin West Mexican objects (Type 1a, Fig. 6) lack both the design attributes and mechanical properties to have been used as tools, and they were not so used. In fact, two of three Hosler examined, having been hammered and annealed in shaping, were left in an annealed condition (Fig. 25; note the difference in microstructure between Figs. 25 and 26). Their microhardness values, ranging between 60 and 95 VHN (Hosler 1986: 299–302), are evidence of the relative softness of the metal.

All of the curved blade axe-monies (Type 2a, Fig. 7) were similarly shaped through sequences of cold work and annealing, but during fabrication the tips of these blades were intentionally upset to thicken them, providing a blunt, squared-off, firm edge. The tips were then hardened through cold work; typical microhardness values at the blade edge run from 90 to 157 VHN, with hardness increasing toward the tip. In three out of four examples studied, Hosler found these axe-monies deformed at the tip (Fig. 27), but it is unclear whether that deformation occurred accidentally or resulted from use. In general, these blunt blades are not sharp enough to have functioned effectively as knives or as cutting or splitting tools, like small hatchets. They are hard enough only to cut or scrape soft or fibrous materials; the blunt, upset edge might have been advantageous in scraping (Hosler 1986; 302–306; 310–311). Morse and Gordon (1986) suggest that these axe-monies may have been used for chopping soft foods, but unless the shank were hafted the raised flanges (see Fig. 28) along both sides would not provide an adequate or comfortable grip for such action.

The main difference between the axe-monies with a curved blade (Type 2) and those with a flaring blade (Type 3a, Fig. 29) is in the form of the blade edge: blades of the latter type taper to a sharp edge. Of three examples studied metallographically, one was left in the annealed condition and is therefore quite soft. In both of the others the blade edge has been cold worked to harden it. In one case, the elongated grains at the extreme tip appear to shear off (Fig. 30) as if the metal had been sharpened or abraded. Microhardness values near the edge range from 98 to 136 VHN at the tip itself. In the other case, the metal at the blade edge is deformed, deformation having blunted the tip.

Again, it is unclear whether the deformation was caused accidentally or through use of the object. Microhardness values at the tip range between 125 and 138 VHN (Hosler 1986: 307–309).

The laboratory evidence that these axe-monies may have served as utilitarian implements is equivocal. Type 2a objects present the best case for use, as all (including one Easby studied: Easby et al. 1967: fig. 25) were cold worked at the blade to increase its hardness. Some were deformed subsequent to manufacture. The evidence from Type 3a objects is ambiguous at best. Some were left annealed and quite soft; others were work-hardened and could have been used.

In general, however, Type 2a and 3a objects are only marginally adequate as tools. Whereas some of the West Mexican axes Hosler examined (Hosler 1986: chap. 5) were no harder than these axe-monies, the axes were designed sufficiently thick and have sufficient heft to have performed well as splitting implements. The upset blades of the axe-monies disqualifies them as effective cutting tools. Thus neither of the two main technical studies of the Mexican corpus—Easby's (1967) initial look at the Oaxacan material and Hosler's (1986) systematic and comprehensive study of the entire range of these objects—has provided compelling evidence for the use of Mexican axe-monies as tools.

The design and mechanical property criteria that distinguish a serviceable tool from one that is not are reasonably straightforward. On the other hand, to decide whether a group of objects may have served as a kind of standard—in this case a standard of value in exchange—is more difficult, because the criteria for standardization may be multiple. In terms of fabrication, one must evaluate standardization while being cognizant that certain techniques of manufacture and material compositions may be required to produce a certain design successfully. Standardization can be said to exist in a corpus of artifacts only when a selection is made and adhered to from among a range of choices in designs, compositions, and fabrication regimes. In a nonindustrial metallurgy, such a selection cannot be manifest in precise replication of composition and design, but will be visible in the limits imposed on the range within which certain attributes can vary. To assess whether that range of variation constitutes a standard further requires that it be compared with data from another artifact class—here, Mexican axes—which is formally similar but whose design is not standardized (Hosler 1986: 318–319).

Hosler (1986: 318–330) considered the question of standardization within the corpus of Mexican axe-monies from the point of view of both design and fabrication technique. Types 1a, 2a, and 3a objects constituted the primary corpus of study. She found sufficient variation among these types to indicate that objects with their particular design constraints and which served their particular cultural function showed definite differences in manufacturing procedure, such as in the use of copper for some and of the copper-arsenic alloy for others, or the final annealing of some and the final cold working of others. In terms of manufacturing regime per se, the axe-monies do not appear to have been standardized, although there is some tendency towards patterning within any one type (Hosler 1986: 319).

The material used, by contrast, does show a high degree of consistency. Of 30 objects analyzed, only six are made of copper; 84% are fashioned from the alloy of copper and arsenic. Whereas the concentration of the alloying element was not systematically controlled (see Table 2 and Fig. 50), the fact that these objects were almost always made from this material is highly significant. It appears that the use of this particular alloy, while not technically necessary, was in some sense a defining characteristic of these objects. The most consistent evidence occurs in the Type 1a objects where, in fact, the alloy was critical to the design. These objects would not have survived had they been made of copper alone.[10]

[10]The addition of relatively small amounts of arsenic to copper increases the hardness of the resulting alloy. For example, the hardness of copper containing only 0.5% arsenic will be increased by about 20% over that of the pure metal as each undergoes a reduction of 25% in thickness. Similarly, after a 90% reduction in thickness, the alloy will maintain a hardness 20% greater than that of copper that has undergone an equal amount of plastic deformation. At higher arsenic concentrations, corresponding to the arsenic bronzes, hardness continues

Table 3 presents data on the lengths and weights of all items in the corpus studied. The mean lengths exhibit virtually no variation among the three types, and the same can be said for the mean weights of Types 2a and 3a. In addition, the ranges within which length and weight vary within any one type are narrow. To evaluate the extent to which these data represent "standardization" of a type or types, Hosler compared them to Mexican axes which the axe-monies approximate in size and shape (Hosler 1986: 327–330). The comparison was made with two groups of axes, one from the Solórzano collection of the Museo Regional, Guadalajara, which contains items primarily from West Mexico, and axes from various collections in Oaxaca. The mean length of the West Mexican axes is 11.2 cm, but the range of lengths varies between 6.4 and 16.0 cm; the mean length of the Oaxacan axes is 11.7 cm, with a range of 6.0–17.0 cm. By consulting Table 4, it is evident that the range of lengths exhibited by the axes is considerably broader than that of the axe-monies, whose lengths within any one type are tightly clustered. The weights of individual axes within the two geographic groups show continuous but quite wide distributions: West Mexico, 29–600 g (mean of 204 g); Oaxaca, 12–2000 g (mean of 391 g).

This comparison of lengths and weights of axe-monies and axes shows the difference between an artifact type that is relatively standardized and one that is not. With respect strictly to dimensions and weights, the evidence indicates that the axe-monies were being manufactured to conform to a relatively narrow range of lengths, weights, and forms (Hosler 1986: 330). They were standardized.

Mexican axe-monies were not axes, and they were monies only in the sense that Holm has designated "primitive money": restricted in value and circulation and with a specific rather than with multiple functions (Holm 1978). They were used, along with cacao beans and *mantas* (shawls or cloths), as a medium of exchange and, as such, were standardized in form and material. In this sense the argument can be made that they represented a standard of value in exchange, but we have no evidence thus far of their relation to any of the other "standards"—the bean and textile "*monedas*"—the Spaniards witnessed in circulation at the time of the invasion. They were also tribute items, especially Type 1a, the West Mexican variety which was fabricated solely for that purpose. The thinness and lightness of the West Mexican objects make them highly portable, and if they customarily were stacked and bound in packets such as the one Weitlaner (1947) collected, they could easily be divided and distributed. That may have been important if the metal was eventually melted down for reuse. The Type 1a axe-money may have provided a source of copper metal containing arsenic in low concentration, an alloy especially suitable for tools (Hosler 1986: 331–332).

The choice of shapes of axe-monies is particularly significant. Type 1a objects resemble ancient West Mexican axes used for cutting and splitting wood. The axe was an important symbol of power in West Mexico and elsewhere in Mesoamerica, with ritual and ceremonial functions (Hosler 1986: chap. 5). Thus the form assumed by Type 1a *hachuelas* represents a tool and the symbolic import of that tool. On the other hand, Type 2a and especially Type 2b axe-monies (Fig. 32) are shaped like mushrooms.[11] The line drawing (Fig. 31) of Francisco Tenorio (Medina 1912: 562), though idealized, is far more reminiscent of these fungi than of an axe. Indeed, the shapes of mushrooms and of these axe-monies are sufficiently alike that

to increase with cold work. A copper-arsenic bronze containing 2% arsenic will achieve a hardness 58% above that of pure copper when each is reduced in thickness by 25%. The same bronze alloy will be 38% harder than copper when both are reduced in thickness by 90%. Thus the thin Type 1a axe-monies, if left in the work-hardened condition, would have survived handling and physical insults far better than had they been made of copper.

[11]Hosler examined 10 Type 2b axe-monies in Mitla, Oaxaca, which she describes as an "extreme mushroom shape" variety (Hosler 1986 and personal communication). Half are considerably heavier than the more standard Type 2b items (weights range from 83.0 to 180.0 g), and three are much longer also (lengths range from 14.9 to 15.5 cm). The length and weight data for this group, corresponding to the data presented in Table 3, are:

Length range [cm]	*Length* mean [cm]	*Weight* range [g]	*Weight* mean [g]
11.0–15.5	12.9	53.5–180.0	99.7

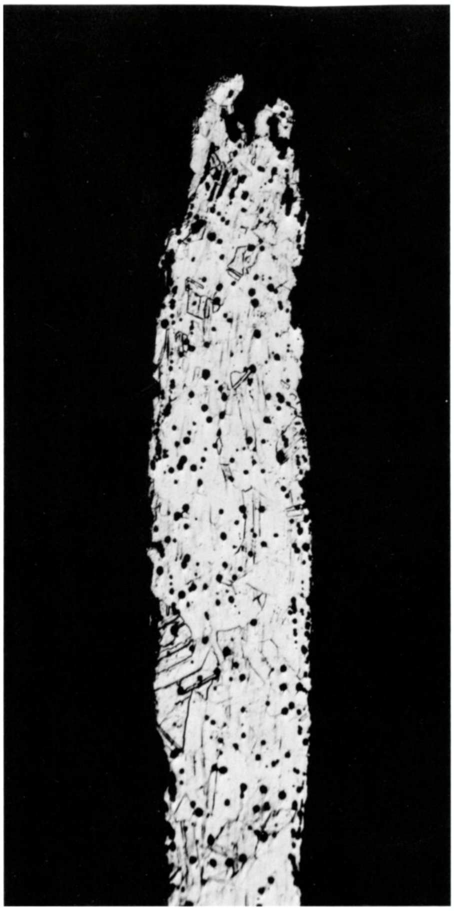


Fig. 25 Photomicrograph of a cross section of metal removed from the tip of the blade of a Type 1a West Mexican axe-money similar to the one shown in Figure 6. The microstructure of this Cu-As alloy reveals equiaxed grains with annealing twins, indicating that the metal, previously cold worked and annealed to shape, has been left in the annealed condition. There has been no subsequent deformation through use. Round cuprous oxide inclusions are somewhat strung out in the direction of flow of the metal as it deformed plastically during shaping of the blade tip. Alloy: Cu, 0.60% As. Magnification: 100. Etchant: ammonium hydroxide + hydrogen peroxide.

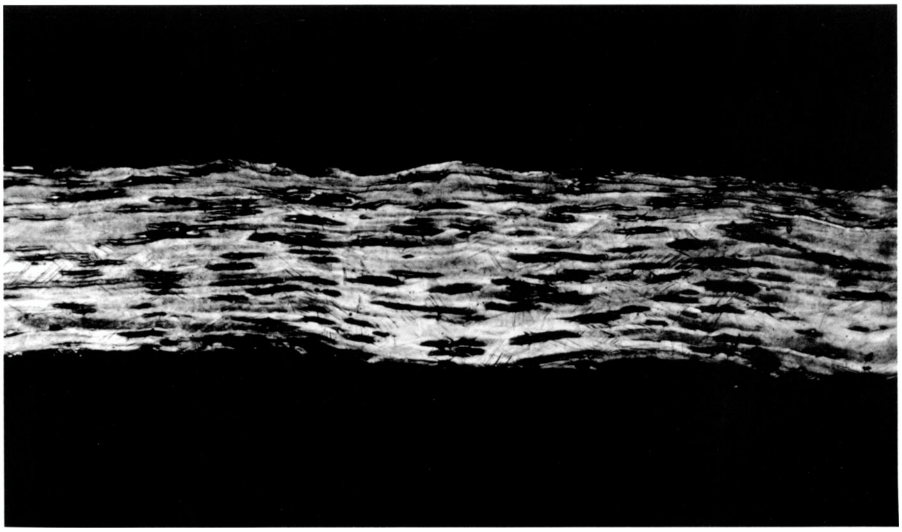


Fig. 26 Photomicrograph of a cross section taken transversely across the shank of a Type 1a West Mexican axe-money similar to that shown in Figure 6. The microstructure reveals a highly segregated alloy that has been severely deformed through sequences of cold work and annealing. The banded appearance, oriented in the direction of metal flow, indicates the extent to which the original cast blank was compressed as it was hammered into thin sheet. In this case, as distinct from the microstructure shown in Figure 25, the metal was worked slightly subsequent to the final anneal; grains with deformation lines appear scattered throughout the section. Alloy: Cu, 2.82% As. Magnification: 200. Etchant: potassium dichromate.

Fig. 27 Photomicrograph of a cross section of metal removed from the tip of the blade of the Type 2a Oaxacan axe-money illustrated in Figure 7. The metal at the tip has been upset, deliberately compressed to thicken it and to provide a firm but blunt edge. The etched section reveals flow lines in the inhomogeneous Cu-As alloy that run parallel to the axis of the section but splay out at the blade tip, recording the direction of metal flow as the tip was thickened. Subsequently some further action blunted the blade, contributing to the slight peening over of the metal. This deformation may have been from use or from accident. The relatively large and equiaxed grains with annealing twins farthest from the blade tip (toward the bottom of the micrograph) become elongated and disorganized at the tip. The blade of this axe-money was left in the annealed condition except at the tip itself where it was cold worked to thicken and strengthen it. Deformation lines characterize the distorted grains at the tip. Alloy: Cu, 0.19% As. Magnification: 100. Etchant: ammonium hydroxide + hydrogen peroxide followed by potassium dichromate etch for silver.

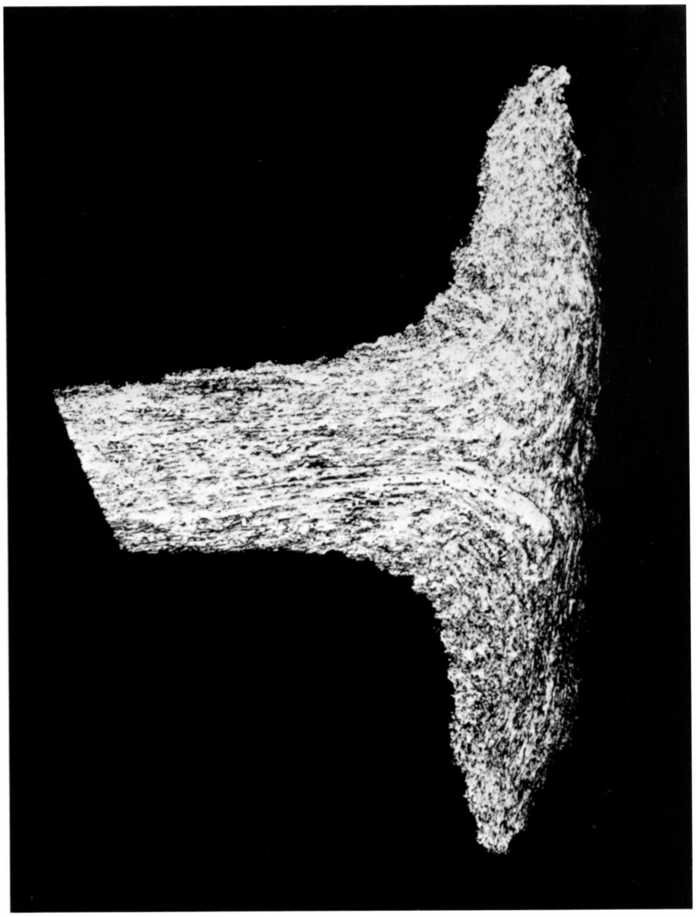


Fig. 28 Photomicrograph of a transverse cross section cut through the edge of the shank of a Type 2a axe-money, similar to the one shown in Figure 7. The microstructure clearly reveals how the prominent edge flange was formed. The flow lines in the shank are oriented parallel to its transverse axis, but at the edge they splay out, bending above and below the axis, as the metal deformed plastically under the blows of a hammer. This is the typical microstructure of an upset edge, formed by compressing the metal and pushing it back upon itself. The grains in the shank are slightly elongated and aligned with the direction of metal flow. At the base of the flange, some grains are equiaxed with annealing twins, but at the surface the grains are so compressed from the final hammering this zone received that their outlines cannot be resolved. Note how much higher and more severe the flanges on the Mexican axe-monies are than are those of the Ecuadorian examples (see Fig. 36). Arsenical copper (0.07% As). Magnification: 20. Etchant: potassium dichromate.

Fig. 29 Type 3a axe-money, Oaxaca, Mexico. Collection: Museo Regional de Guadalajara, Guadalajara, Mexico (MRG F347; MIT 3465).

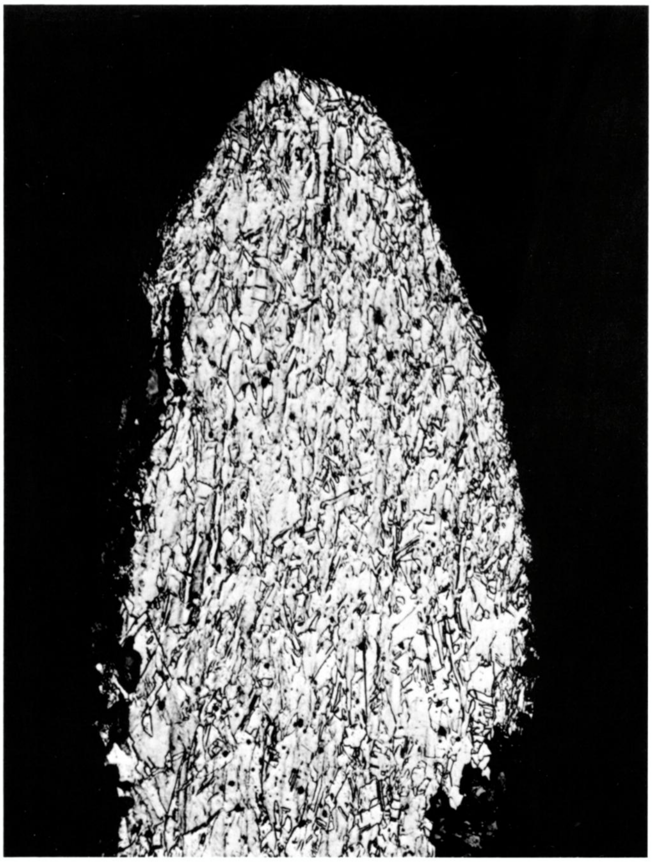


Fig. 30 Photomicrograph of a cross section of metal removed from the tip of the blade of the axe-money shown in Figure 29. This object underwent a series of cold work and annealing operations to shape it from a cast blank. The microstructure reveals highly elongated grains with annealing twins, indicating that the metal was worked subsequent to the final anneal but not sufficiently to initiate development of deformation lines within the grains. The blade tip comes to a fairly sharp point where the elongated grains appear to shear off as if the metal had been sharpened or abraded. There is no microstructural evidence to indicate that the metal was deformed subsequent to fabrication of the blade, however, either by use or by accident. Arsenical copper (0.02% As). Magnification: 100. Etchant: ammonium hydroxide + hydrogen peroxide followed by potassium dichromate etch for silver.

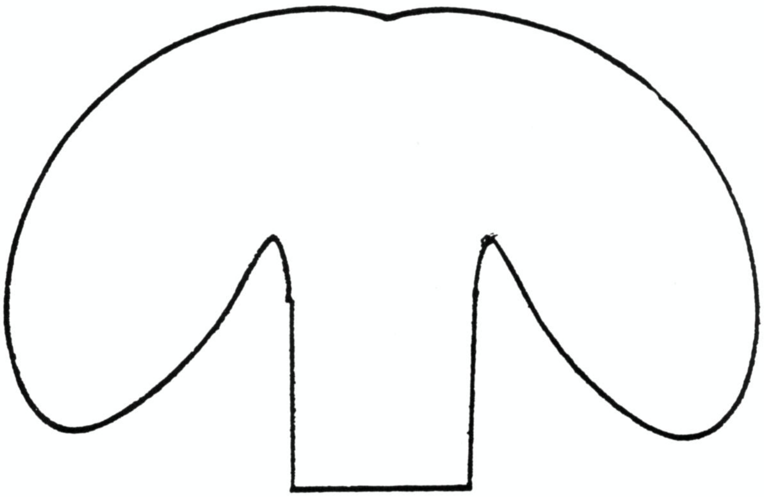


Fig. 31 "This is the kind of copper currency [coins] which were used in New Spain." From a 1548 letter by Francisco López Tenorio, Regidor de Antequera, to the *presidente del consejo de Indias* in Spain. Line drawing after Medina 1912: 563.

Fig. 32 Type 2b axe-money, Xaaga, Oaxaca, Mexico. This mushroom-shaped example is one of several, from a cache of 120 axe-monies, that Marshall Saville deposited in 1900 in the American Museum of Natural History, New York (AMNH 30/8529).

the mushrooms in the *Codex Vindobonensis* have been misidentified as axe-monies (Melgarejo Vivanco 1980: 49). Caso (1963) has demonstrated, however, that such objects shown in the codices are mushrooms. Mushrooms were considered divine beings in Oaxaca (Furst 1978: 206). After careful ritual preparation of the participants, mushrooms were ingested, always in pairs, and in the trance that followed their knowledge and advice were sought. The pairs were conceived of as complementary male and female beings (Furst 1978) associated with fertility. Some depictions of mushrooms in the codices show them held in pairs by deities.

At least one piece of archaeological evidence links these Type 2 axe-monies to mushrooms. In 1900 Marshall Saville attached a note to a group of axe-monies currently in the American Museum of Natural History, New York, when he deposited the collection there; it states that the objects (one of these is shown in Fig. 32) came from a cache of 120 axe-monies that had been placed in pairs in a chamber excavated in a mound near Xaaga, Oaxaca (Hosler 1986: 333). As this evidence suggests, if Type 2 axe-monies were indeed made to simulate mushrooms, then any use of axe-monies as implements was casual and an afterthought. Their shape, rather than their utilitarian purpose, was probably the most important attribute of these objects. It is likely that mushroom-shaped axe-monies, used for exchange and tribute in ancient Oaxaca, also elicited powerful religious responses (Hosler 1986: 334).

Ecuador

A possible utilitarian function for Ecuadorian axe-monies has never been an issue as it has for the Mexican material. Axe-monies of the normal size are too small and too thin to have served as tools (they weigh, on average, about 18 g); they have a squared-off, blunt blade edge (Fig. 36); and the presence of a continuous edge flange along the perimeter would have made hafting difficult (Figs. 1, 2). Their form is definitely that of an axe, and they are reasonably close in shape to larger, heavier metal axes that are contemporary with them (Figs. 33, 34). Whether such metal axes or stone axes served as the formal models for the axe-monies is uncertain, but we are beginning to assemble substantial evidence, based on the metallographic examination of metal axes from both coastal and highland Ecuador, that many of these larger axes were never used as tools. Lechtman studied four Ecuadorian metal axes, ranging in weight from 39 to 252 g, chosen expressly for their formal similarity to the normal size axe-money. All four are from the Jama Coaque coastal region in northern Manabi, and are therefore just outside the Milagro-Quevedo/Manteño culture area. They are Integration period in date. All are made of copper-arsenic bronze, their arsenic content ranging between 1.1 and 3.8 weight percent (see Table 2). The lightest and the heaviest are shown in Figures 33 and 34. The major formal departure of these axes from axe-money is the presence of a hole in the shank near the butt end. The rectangular hole punched out of the shank of the axe in Fig. 33 is a unique occurrence; holes on all other examples, including a large class of heavy axes with curved blades, are round and are cast into the original blank from which these axes were later shaped by hammering and annealing. Otherwise, axes of this general type share with axe-monies the continuous border flange and squared-off, blunt blade edge.

Metallographic examination of the four axes yields two results. First, the platform formed by the broad flange at the butt end has sustained no deformation, as it would have, for example, had it been hammered on through chisel-like use of the object: the platform of the lightest axe was left in a fully annealed condition, and those of the others are either annealed or exhibit slight, superficial working. Second, none of the blades shows any sign of use: the blade of the lightest axe was left fully annealed, and the blades of the others exhibit equiaxed grains with some deformation bands, the typical microstructure occasioned by slight and superficial working of a blade in refining its shape. The blunt, squared-off blade edge of the heaviest axe (Fig. 35) was clearly achieved by thickening through upsetting, just as Hosler has demonstrated for the Mexican Type 2a axe-monies.

Ecuadorian axe-monies are variations on a small

scale of certain axe types and share most of the features of the larger axes, including their non-tool function. Figure 36 presents a cross section through the blade of the axe-money illustrated in Figure 2. The raised flange of the shoulder and the thickened, squared-off, blunt blade edge contrast markedly with the much thinner metal of the blade itself. The section reveals the locations on both surfaces of grooves or striations hammered into the metal. The microstructure of this example and of many other axe-monies of all sizes we have examined metallographically indicates unequivocally that these surface markings were made with a tracing tool struck upon the surface to compress and indent the metal. They were not made with a graver, which would have cut and removed metal. The severe deformation of the thin metal plate beneath each of these surface indentations, as shown by the contours of the flow lines, the elongation of the grains, and the criss-crossed deformation lines within grains (Figs. 37 and 38), indicate the extent of the pressure applied by the tool. From the shape of these grooves (see Fig. 2)—of uniform width and depth along most of their length, but narrowing to a shallower point at both ends—we can assume that the blade of the tracing tool was slightly curved. In addition, the photomicrograph of Figure 36 demonstrates that the groove channels are impressed at an angle to the surface; this was common practice, as the tracing tool was often held obliquely when struck. Many of the finest striations visible on axe-monies of all sizes were made by tapping the tool lightly as it was moved fractions of a millimeter from one strike to the next, creating a cluster of fine lines that are almost geometrically parallel. Holm correctly identified these "legitimating" marks as traced grooves in his earliest visual inspection of the objects (Holm 1966/67).

That certain axes, as well as axe-monies, served no technical purpose in the Americas should no longer come as a surprise. Hosler's laboratory study of Mexican axes has shown that many were never used as tools. The ethnohistoric evidence she assembled is clear about the symbolic, ritual, and political use of the axe in Mexican society (Hosler 1986: chap. 5). At the moment we have far fewer European sources at hand which bear upon the cultural context of axes among indigenous Ecuadorian peoples, but a few are beginning to clarify the picture. Salomon (1987) describes the contents of a rich Cañari tomb looted by a group of Spaniards in 1563 at a site "about two crossbow-shots" from the important Inka fortress at Ingapirka (Salomon 1987: 218). Eyewitness accounts of the value of the gravewealth varied between 1200 and 3000 pesos, sums which Salomon explains "are comparable with the annual value of tribute income from any of the major *encomiendas* of the time" (1987: 219). Among the items listed before the Cuenca authorities by eyewitnesses at the looting are hatchets ("*hachuelas*") of copper. The more reliable accounts of their number run from about 600 to over 1000, evidence, Salomon argues, for their presence among Cañari elite as a symbolic form of wealth (1987: 220). The fact that *hachuelas* constituted wealth among Cañari does not necessarily mean that these hatchets had not been used as serviceable implements before they were buried. But Scott's metallographic analyses of Ecuadorian axes from the highlands (Scott n.d.), including the Provinces of Cañar and Azuay, are beginning to reveal a pattern similar to that emerging from our work with the coastal axes, namely, that many show no signs of use. Scott has examined the highland counterpart of the curved-blade axe with shank hole, most of which lack edge flanges while others display cast-in relief decoration. It may have been the presence of such relief motifs that allowed the sister of the deceased Cañari man to identify one of her brother's looted *hachuelas* (Salomon 1987: 223). Almost all of the axes Scott has analyzed from the southern highlands are of copper-arsenic alloy (Scott n.d.: table 14).

Another example of the burial of axes in very large numbers in the southern Ecuadorian highlands is given in a brief catalog drawn up by Fray Benjamin Rencoret (1875) to accompany his collection of Ecuadorian artifacts that was shipped to Chile from Ecuador in 1875 for exhibition in the International Exposition held there that year. Among his catalog notes about the copper objects in the collection, Rencoret remarks that the year

before (1874) a woman from the town of Azogues removed "16 quintales" (1875: 17) (736 kg) of copper axes from a tomb she excavated in Guapan, Cañar Province. He goes on to say that the axes were of various sizes and numbered about three thousand in all. "Parecen mas bien armas de guerra que instrumentos de arte" (they look more like weapons than art objects) (Rencoret 1975: 17). Lope de Atienza (1931: 94–95) comments upon the use of *hachuelas* in quite another social arena, as bridewealth among highland peoples in the Quito area. Referring to communities of much more modest means than the Cañari elite, he reports that formerly the family of the bride would receive two "*hachuelas*" in the bride exchange.[12] Atienza's text implies social disorganization and poverty. The fact that this transaction no longer could occur is attributed to the loss in exchange value of *hachuelas*. The pre-1532 "treasure" had become devalued, and no other bridewealth had replaced it. We wonder whether the cessation of manufacture of axes by smiths under the Spanish regime may also have entered into the picture.

The Spanish use of the term *hachuela* in the Ecuadorian context is not as clear as it is in the Mexican case. In Ecuador, the term seems to refer to wealth in the form of a hatchet. The coastal manifestation of *hachuela* is axe-money; the highland version we must assume took the form of hatchets or small axes of various kinds, some decorated, others not, which were exchanged, circulated, amassed, and buried. Given the fact that no axe-monies have thus far been found in any highland context, we suspect that Spaniards used the term *hachuela* indiscriminately to refer to a variety of Ecuadorian axe-like forms because they recognized that all were used in some manner as wealth. We consider it unlikely, therefore, that the eyewitnesses who reported on the hundreds or thousands of *hachuelas* looted from the Cañari grave were referring to axe-monies or that "the Cañar data may . . . be taken as proof that the coastal "money axe" complex extended into the Cañar highlands, presumably as part of a prehistoric trade net" (Salomon 1987: 221).

That the axe form in and of itself had symbolic weight among coastal Ecuadorians is remarkably demonstrated by the four giant axes from the Milagro-Quevedo culture area (one is illustrated in Fig. 10), each weighing about 20 kg, that were cast in open moulds (Holm 1966/67: fig. 4) from copper-arsenic alloy (see Table 2). The ethnohistoric accounts cited above, all reporting on highland events, indicate the currency of such attitudes throughout the Ecuadorian coast and sierra. As Holm has pointed out, however (1966/67), the European sources do not comment upon the use of axe-monies in a transactional mode, as they do for Mexico. On the basis of his excavations at Loma de los Cangrejitos, Jorge Marcos has suggested (personal communication, 1988) that axe-monies may no longer have been in circulation at the time of the Spanish invasion. At Cangrejitos, axe-monies are present from about A.D. 900 until approximately A.D. 1400, but they cease being offered as grave goods after that date. None is

[12]Salomon (1986: 13) describes Lope de Atienza as enjoying a long career as a "middle-level church functionary." He wrote in Spain for a Spanish public, some time between about 1572 and 1575, to explain at first hand how unsuccessful the evangelization of north Andean peoples had been. Atienza's highland parish was located in Chimbo, in the modern Province of Bolivar, on the western slopes of the cordillera facing the coastal plain inhabited by Milagro-Quevedo peoples in pre-European times. He was evidently familiar with many practices of the lowland ethnic communities, mentioning, for example, their use of the fruits of wet tropical forest trees, such as *Bixa orellana* (Atienza refers to *vandui*, which is *bandur* in Quechua: 1931: 36) and *Genipa americana* (Atienza writes *jugua*, which is *jigua* or *jagua* in Quechua: 1931: 37) for red and black body paints (see also Estrella 1988), and commenting upon their habit of inserting gold plugs in the incisor teeth for cosmetic purposes (1931: 54).

Although we cannot delimit the geographic extent of his parish, we know from Atienza's writings and others as well that there was a shortage of priests to carry out the missionary work. Under such circumstances, and given his clear familiarity with coastal Huancavilca culture traits, we ought not to consider that his duties were limited by the highland ethnic or linguistic boundaries of his parish see. Thus his reference (1931: 94–95) to an Indian father who laments the giving away of his daughter in marriage without receiving two copper axes in bridewealth, as in previous days, need not necessarily describe a highland situation. It might just as well relate bridewealth exchange in axe-monies among coastal dwellers. If, in an effort to clarify the "frontier" area between coast and highlands, philological studies of toponyms of the present Provinces of Bolivar and Los Rios were undertaken, they might produce results similar to those Holm has obtained in comparing Cañari toponyms with obvious coastal place names (Olaf Holm, personal communication). Holm has been able to show that the Pre-Columbian Cañari frontier was at the footplain of the western cordillera.

associated with any contact period graves. Ubelaker (1981) found no axe-monies at Ayalan in the one urn burial that contained European glass beads, and no axe-monies were part of the rich Cacique Guayas burial at La Compañia (Meggers, Evans, and Estrada n.d.).

The *hachuela,* in its several forms, was one of a host of objects and materials that circulated as wealth throughout the Ecuadorian region prior to the Spanish invasion. The Cañari grave, like the Cacique Guayas burial, is an inventory of such items. Among them, those which appear to have had the widest distribution are small pierced beads of *Spondylus* shell and of gold, referred to by the Spaniards as *chaquira,* and *hachuelas* which we must now read as axe-monies for the coast (Provinces of El Oro, Manabi, Guayas, and Los Rios) and as hatchets or small axes in the highlands. It is clear that *hachuelas* constituted a form of wealth and that they were often hoarded in great quantity. What is at issue here is whether or not they served as tribute and/or were a medium of exchange in transactions other than those that were kin-based, as in bridewealth exchange. The presence or absence of standardization in production of axe-monies has a bearing upon these questions. We have not yet compared the corpus of axe-monies to axes in Ecuador as Hosler has for Mexico to test the limits within which the patterning in production characteristic of *hachuelas* is distinct from that of axes. It is evident, however, that only the axe-monies occur in what we have referred to as small and tiny sizes and that only such axe-monies were tied and packeted.

From the point of view of manufacture alone, it can be seen that two methods of production were used, one for the normal size and some small size axe-monies which have edge flanges, and the other for some small and all tiny axe-monies which are without flanges but whose edges are thickened. Axe-monies that are large and thick enough to support raised edge flanges were manufactured by hammering a thin blank of metal that had been cast roughly to the shape of a small axe. The subsequent extensive working of the blank to achieve the final form required frequent intermittent anneals as the metal was thinned down to plate or sheet. Both the raised flanges along the perimeter and the squared-off blade edge, the last features executed, were achieved by upsetting the respective edges: hammering the metal in upon itself to thicken and spread it. When shaping was complete, the piece received a final anneal to soften it somewhat, facilitating the execution of the surface grooves by localized plastic deformation of the metal under the tracing tool.

By contrast, the small and tiny axe-monies with thickened edges (Figs. 11, 12, 39) were made directly from previously prepared sheet. Because the sheet was so thin, its edges could not be upset to provide flanges or to thicken them, yet the thickened border was necessary for the physical integrity of each piece. In this case, the roughly rectangular axe-money shape (Fig. 39) was hammered within (i.e., interior to) the prescribed borders the object was to have. The hammering thinned the metal within these borders, sometimes to the thickness of foil, leaving the borders or edges largely untouched. This solution maintained the thickness of the parent sheet at the edges—which are often two or three times as thick as the interior metal—while the interior was increasingly thinned (Fig. 40). The finished axe-money was then cut out of the sheet with a sharp chisel which often left a serrated edge (Figs. 11, 39). The surface striations were emplaced either just before or immediately after the piece was released from the parent sheet (see Fig. 41). Many of the tiny axe-monies are examples of sheer bravura in the hammering and shaping of metal foil. They faithfully reproduce all of the identifying and distinctive features of this class of object. As we have already mentioned, all Ecuadorian axe-monies we have analyzed are made of copper-arsenic alloy, regardless of their size (see Table 2).

We have observed no departures from these two manufacturing regimes. They are a function of the relative dimensions, including thickness, of the item in production. Axe-monies were made in three sizes: normal, ca. 7.7–8.9 cm; small, ca. 6.5–6.9 cm; tiny, ca. 1.2–4.5 cm. There is almost no variation in size within each of the normal and small size groups (only two items measuring 10.2 and 10.5 cm in length have been observed in the

normal group); the tiny items show a threefold spread in length and, commensurately, in thickness. There are only two fundamental axe-money shapes, those with a shoulder and those without (see Fig. 1). As the tiny axes shrink in size, the shoulder tends to be lost.

We consider packeting the last stage in the production sequence, as it seems clear that the tiniest items are unlikely to have been used individually, simply because of their fragility. An object made of 20-micron-thick foil which is 8 mm in length will not withstand handling for very long. Normal size axe-monies were apparently never packeted; small ones sometimes were and sometimes were not; tiny ones appear almost always to have been packeted, we presume at the site of manufacture. Holm (1966/67, 1978, 1980) was the first to comment upon the contents of these packets. He noted that they contain only certain fixed numbers of leaves: 20. More recently, Ubelaker's excavations at Ayalan (1981) uncovered many packets, the contents of only some of which could be counted accurately. These contained 5, 10, and 20 leaves. Our metallographic examinations of complete cross sections through three packets of tiny axe-monies have revealed their contents as 15 (Churute: Fig. 42), 18 (Babahoyo: Fig. 43), and 18 (Balao Chico: Fig. 44) individual leaves respectively. We found, as did Ubelaker, that it was often impossible to count the leaves in a packet with any confidence, because they are usually corroded together and leaves at the center of the packet or broken leaves may not be visible on edge. We sectioned entire packets to ascertain their contents as well as to measure the variation in thickness of individual leaves within a given packet. The discovery of two packets with 18 leaves each from two different sites demonstrates either, as Holm has remarked, that someone was shortchanged, or that the current notion that packets were assembled in multiples of five is incorrect. We should keep in mind, of course, that the two packets of 18 leaves may represent packets of 20 which have lost the outermost leaf from each surface. At the same time, we ought to be cautious about reports of axe-money packets that contain 20 leaves, the size most commonly found in the literature, unless some reckoning of leaf count is provided.

Perhaps more to the point is Holm's observation (1978) that the repetition of 20 (we can now say 5, 10, 15, [18], 20) pieces in these packets is striking, because it indicates the use of numbers and fractions or multiples of numbers. "The concept of a fixed or determined number is not an operation found widely in primitive commerce, where marketing or exchanges of different products were based on comparative volumes or weights" (Holm 1978: 351). He goes on to say, however, that Spanish documents of the contact period describe the use of balances among coastal merchants in Ecuador and we may assume, therefore, that weights, numbers, and volumes were absolute values and not arrived at only through commercial calculations (Holm 1980: 60—61). It may be that the number of leaves incorporated in any one axe-money packet was determined by weight, not by number, in which case packets with 18 rather than 20 leaves would not be irregular. Aside from Holm's early efforts to seriate the weights of identical examples of the smaller axe-monies, which showed a tendency to "concentrat[e] in groups around a quinary system: 5, 10, 15, etc. [grams]" (Holm 1966/67: 138), we know of no further studies that have followed this line of investigation. On the other hand, the data gleaned from Peruvian materials concerning the packeting of *naipes* in groups of 20 to 500 leaves (Pedersen 1976; Shimada 1985a) and the tying and packeting of feathers in groups of 10 leaves (Lechtman's examination of Bennett's Lambayeque One material; Bennett 1939) certainly add weight to the observation that leaves, regardless of shape, were bound in packets of multiples of five.

Finally, Holm's suggestion (1980) that the packets of tiny axe-monies represent fractional values of the normal size and variety remains untested; careful weighing of many examples of each type is necessary to evaluate the idea. We should point out, however, that if further excavations bear out the axe-money sequence established by Marcos at Loma de los Cangrejitos (1981), namely, that the normal size objects are the earliest and the small or tiny packets the latest, then we are observing a

change in the formal style and perhaps in the use of axe-monies rather than an internal relation between members of the same class of object.

Taken together, the evidence surrounding the production of axe-monies strongly suggests that the manufacturing sequences and the products issued were standardized in large part, constrained by a fairly narrow selection of materials, routines, and forms. Whether or not axe-monies served as a standard of value, in tribute or in exchange, is still unclear. Certainly they are distributed over the entire culture area associated with the Milagro-Quevedo and Manteño-Huancavilca presence on the central and south Ecuadorian coast (see map, Fig. 13). Both Holm (1978) and Stothert (n.d.b) offer a context within which axe-monies originated and were actively in use. During the Integration period,

> local lords at centers like Salango, Agua Blanca, Manta, Colonche, Chanduy, and Puná controlled labor and resources over areas that included many smaller settlements. The most elaborate features were achieved, predictably, in Manabí and the Guayas Basin, but everywhere a pattern of economic specialization discernible in the archaeological record points to an unprecedented centralization of the system. . . .industries operating at the local level were apparently organized at higher levels, resulting in the movement of textiles, shell, salt, shell beads and ornaments, pearls and pottery from the producer into the hands of the elite. A heightened degree of differential access to goods is clear in the residences and burials at Manteño and Huancavilca sites. (Stothert n.d.b: 8)

The Cacique Guayas tomb is an excellent example of such differential access, with its surprising numbers of heavy gilt copper nose rings, open rings, *clavas de insignia*—hundreds of pieces and kilograms of metal, much of it in copper (Holm 1978), or, as we suspect, copper-arsenic alloy.

These late chiefdoms required the construction of large earth mounds (*tolas*) for their cult, their houses, and their burials. They had set in place a vast agricultural infrastructure for building and maintaining thousands of hectares of raised fields (*camellones*) (Holm 1978). Stothert (n.d.b) points to yet another group of specialists, traders, who were vital to the system, operating, at least in the highlands, in the service of the elite and under the protection of paramount chiefs (Salomon 1986). These same elites, now clearly differentiated, "were capable of extracting more taxes [than in the previous period] which were brought to regional centers like the one at Cangrejito" (Stothert n.d.b: 9).

In this setting, Stothert sees the use of "true tokens of exchange" (n.d.b: 8) in the form of axe-monies as simply another indication of the complexity of coastal chiefdoms of the late period. The sheer numbers in which they were accumulated and buried and their wide geographic distribution suggests that they may have served as an item of tribute. The "quasi-monetary" role of *chaquira* which Salomon (1986, 1987) describes for most of prehistoric Ecuador may have been shared by axe-monies within the domain of coastal chiefdoms. In fact, Salomon (1986: 91–96) draws an interesting analogy between, on the one hand, the *chaquira* treasure-bead complex so widespread in the central and north Ecuadorian highlands and along the Pacific littoral and, on the other, what might be called the hatchet complex. *Chaquira* came in three primary forms: beads of gold, of reddish or white bone, and of *mullu* (*Spondylus* shell). They seem to be, he argues, "glosses of a common concept" (1986: 92), the peoples using any one bead system quite aware of those used by their neighbors. Hatchets appear to have operated in a similar way, different kinds being treasured in different regions. "Here too it would seem that there is in the background a shared concept of the hatchet as a treasure, yet the sierran hatchet, less portable, divisible, and specialized than the coastal 'hatchet-coin' [axe-money], is not likely to have been made for transport and circulation outside its own province" (Salomon 1986: 93). Salomon is quite clear that in the case of beads and hatchets, as with other highly valued exotic goods such as coca and certain personal adornments, north Andean highland nobility had unique procurement and distribution advantages, expressing their personal and political power in disposing of these precious items (1986: 96).

We ought not to expect in Ecuador the equivalent environment for the use of axe-monies as Hosler has established for Mexico. But it is impor-

Fig; 33 Axe with cut, rectangular hole and continuous flange on butt, shank, and shoulder of the blade. N. Manabi. Alloy: Cu, 1.06% As. Collection: Museo Antropológico del Banco Central del Ecuador, Guayaquil, Ecuador (GA 228.2690.84: MIT 3444).

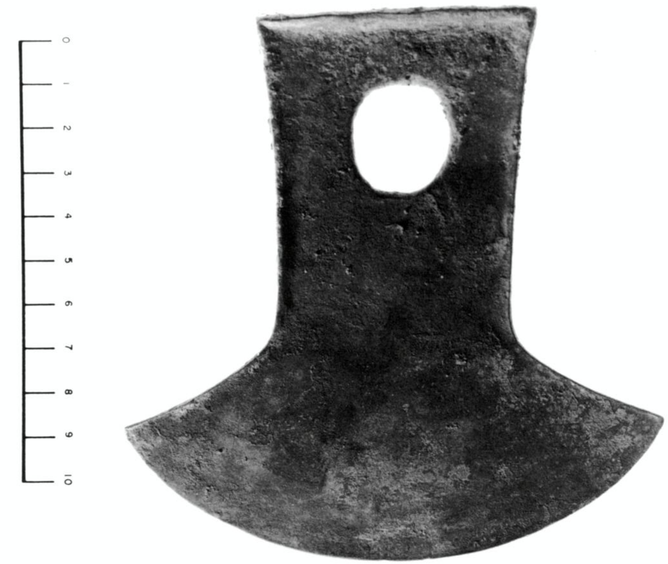


Fig. 34 Axe with cast-in, round hole. The flange is broad at the butt end, almost platform-like, and decreases rapidly in height along the edges of the shank and shoulders of the blade. N. Manabi. Alloy: Cu, 3.81% As. Collection: Museo Antropológico del Banco Central del Ecuador, Guayaquil, Ecuador (GA 61.2008.81; MIT 3447).

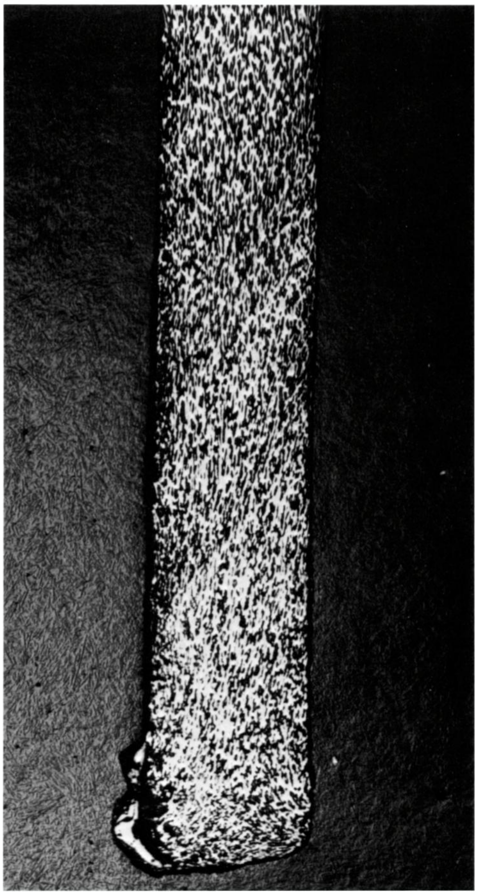


Fig. 35 Photomicrograph of a cross section removed from the blade of the axe shown in Figure 34. The section was cut from the blade tip, at the midpoint of the blade. The alloy, high in arsenic, is highly segregated, and vestiges of the dendrites in the original cast blank are still present and visible, particularly at the tip itself. The original cast structure is severely deformed as the metal underwent considerable working, with the dendrites aligned in a parallel fashion along the direction of metal flow. The tip has been hammered into a blunt, flat edge, the upsetting action deforming the metal and orienting the vestigial dendrites at right angles to those in the body of the blade. Magnification: 11. Etchant: potassium dichromate + ferric chloride.

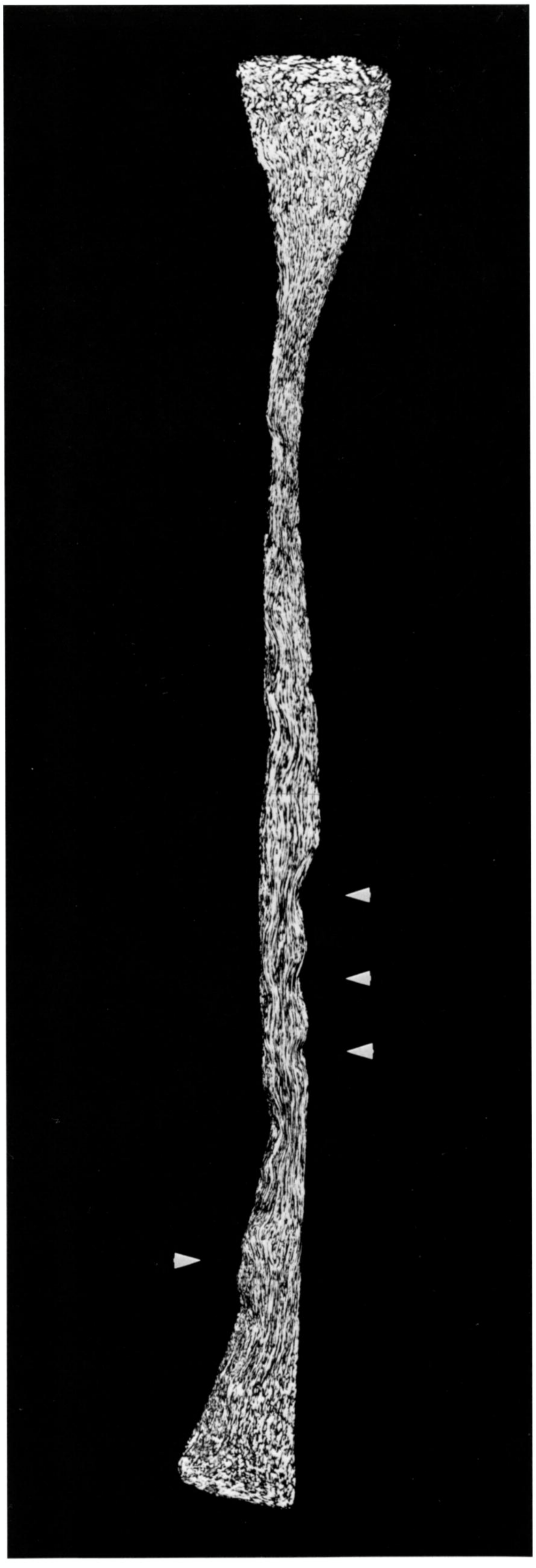


Fig. 36 Photomicrograph of a cross section removed from the blade of the axe-money illustrated in Figure 2. The vertical orientation of the photomicrograph corresponds to the direction of the cut: from the shoulder of the blade straight down through the blade tip. The raised flange (top) and the broad, flat tip (bottom) are about three times the thickness of the body of the blade. Both ends were thickened by upsetting. The flow lines of the highly segregated alloy reveal the extreme compression of the metal as it was hammered to shape. The sharp indentations on both surfaces of the section (see arrows) correspond to the locations of horizontal striations in this portion of the blade (see Fig. 2). Alloy: Cu, 1.81% As. Magnification: 11. Etchant: alcoholic ferric chloride.

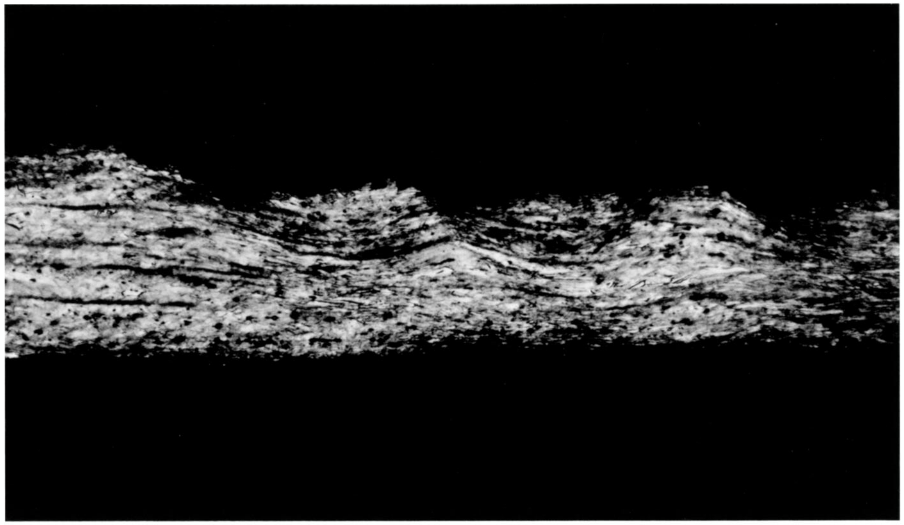


Fig. 37 Photomicrograph of a cross section through the blade of an axe-money similar to the one shown in Figure 2. The photograph has been placed horizontally on the page to correspond to the orientation of the metal sheet during working. The flow lines immediately beneath the three surface indentations (striations) have a wavy contour, following the surface topography closely. Where the tool struck the sheet from above to form the groove, the pressure beneath the tool compressed the metal, and the lines of flow exhibit that compression as they dip down in the region beneath the grooves. As a result of the severe working of the metal directly beneath the grooves, these zones etch rapidly in comparison with the material at either side and appear much darker in the micrograph. Alloy: Cu, 0.71% As. Magnification: 50. Etchant: alcoholic ferric chloride.

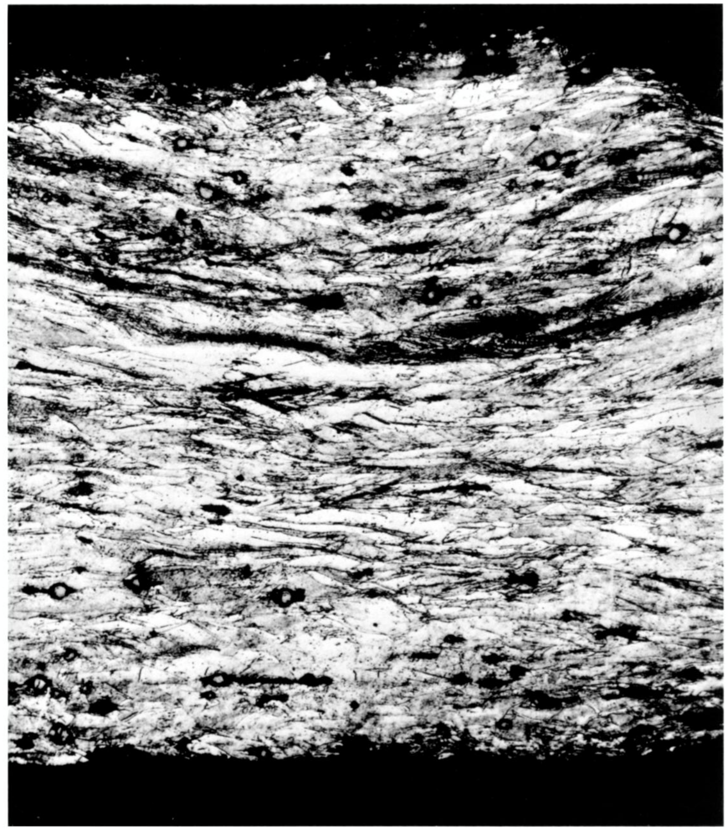


Fig. 38 A more highly magnified detail of the section shown in Figure 37 at a location just to the left of one of the surface indentations. Individual grains are highly compressed, distorted, and elongated. Many, especially those near the upper surface, contain criss-crossed deformation lines. Small inclusions are strung out in the direction of metal flow. Magnification: 200. Etchant: alcoholic ferric chloride.

Fig. 39 Type 1b axe-money from Babahoyo, Ecuador. Note the jagged vertical edges left by individual bites of a sharp chisel and the fine surface striations hammered into the thin sheet. Collection: Museo Antropológico del Banco Central del Ecuador, Guayaquil, Ecuador (MIT 3454).

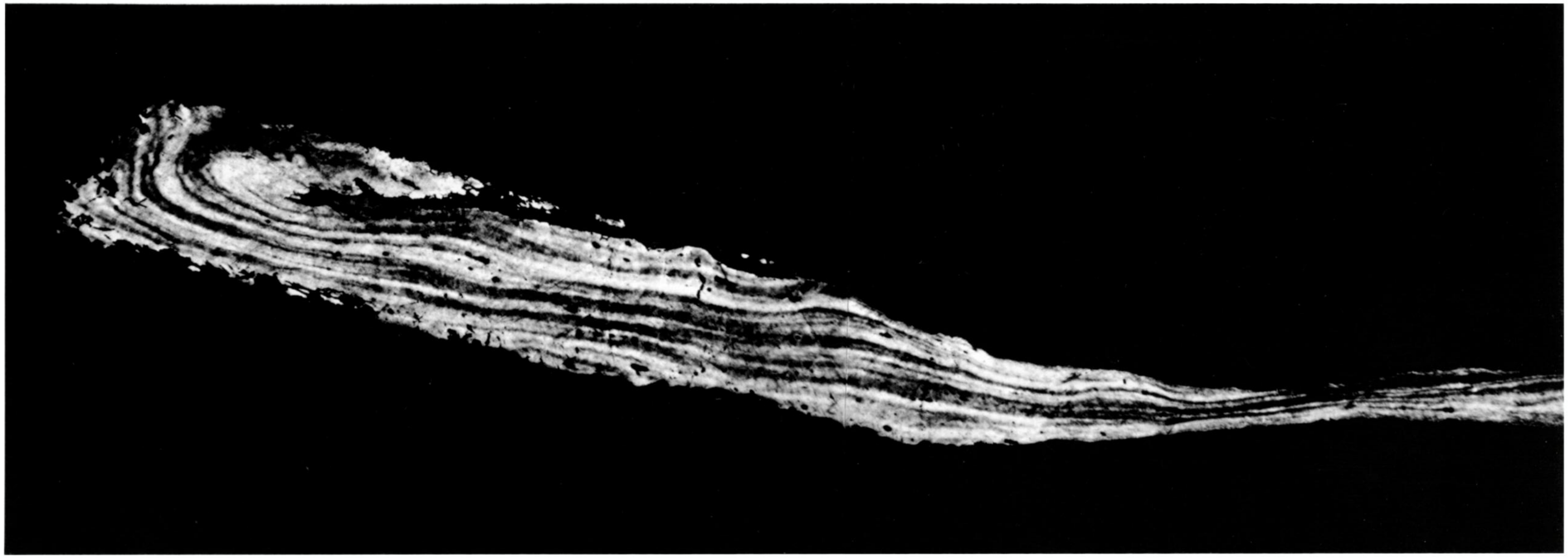


Fig. 40 Photomicrograph of a cross section cut transversely, across the shank of the axe-money illustrated in Figure 39. This is a detail of the edge of the shank showing the dramatic difference in thickness between the metal at the edge and that of the body of the piece. The flow lines are parallel and continue from the body out to the edge, demonstrating that the thick edge was not formed by upsetting. Once the desired edge thickness was achieved (with some minor folding over of some excess material), the edge ceased to be worked, and all subsequent thinning and shaping of the sheet occurred interior to the border. The edge has the form of a long, rectangular rim which proceeds all around the perimeter of the small leaf-like object. Alloy: Cu, 0.81% As. Magnification: 100. Etchant: alcoholic ferric chloride.

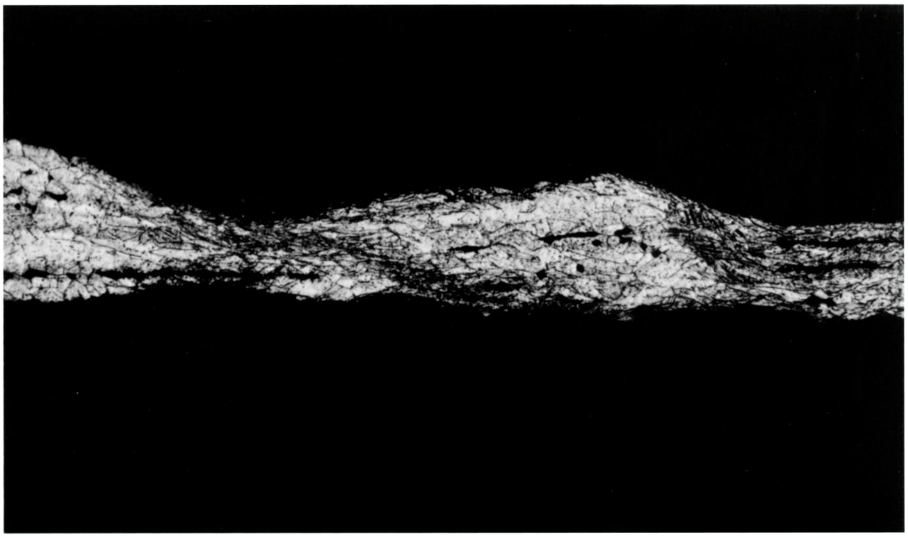


Fig. 41 Another region of the cross section illustrated in Figure 40. The photomicrograph was taken at a location on the section where there are two deep surface grooves (striations). The metal directly beneath these grooves is much thinner than that of the adjacent areas, having been severely compressed by the strike of the tool. Individual grains in these compressed regions are so deformed that they cannot be distinguished; instead, the dark etching zones are characterized by densely spaced deformation lines. By contrast, the metal between the grooves exhibits equiaxed grains with annealing twins. Thus the sheet was left in the annealed condition once shaping of the artifact was complete. The grooves were added as the final surface detail. Nonmetallic inclusions appear as long stringers oriented in the direction of metal flow and indicate how severely the metal was worked to form the thin sheet. Magnification: 200. Etchant: alcoholic ferric chloride.

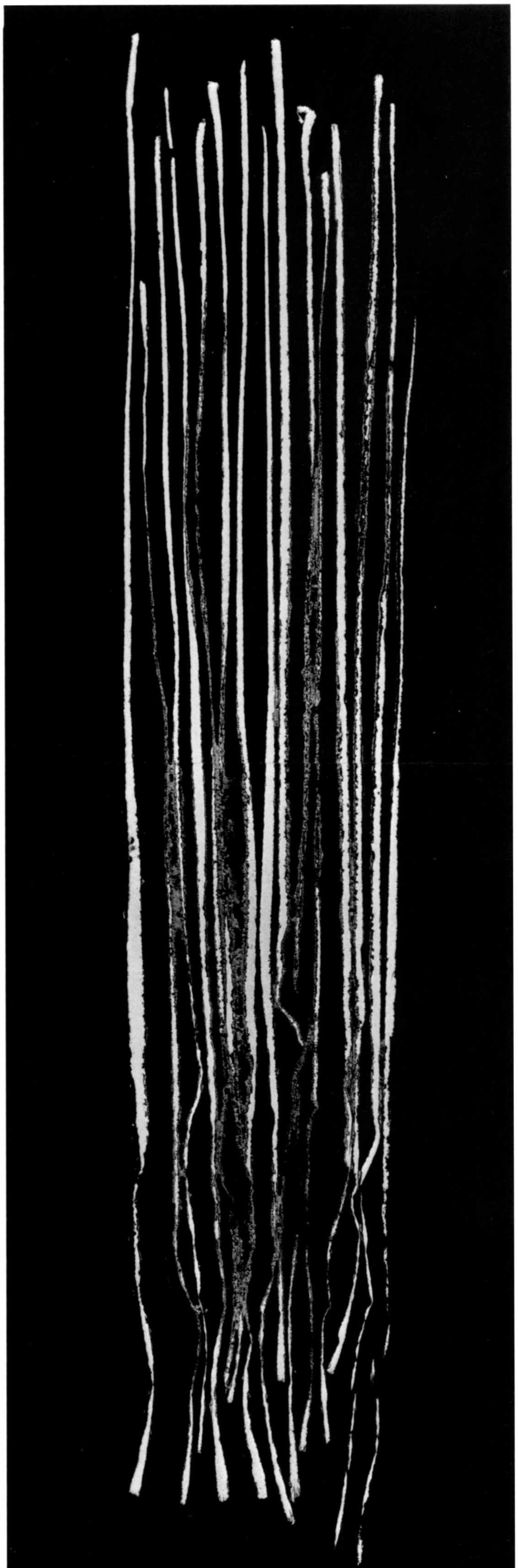


Fig. 42 Photomicrograph of a longitudinal cross section cut along the midline of the packet of Type 1b axe-monies, from Churute, Ecuador, illustrated in Figure 12 (packet at the left). The section runs from the butt end of the packet (top) through the blade end; the photomicrograph is oriented on the page to correspond to the plane of the section. Fifteen individual leaves are stacked in this packet. Note the thickened edges of most leaves and the rectangular form of such edges, similar to the edge shape shown in Figure 40. Alloy: Cu-As; As varies from 0.7 to 1.5% in individual leaves. Magnification: 7.5. As polished (MIT 3436).

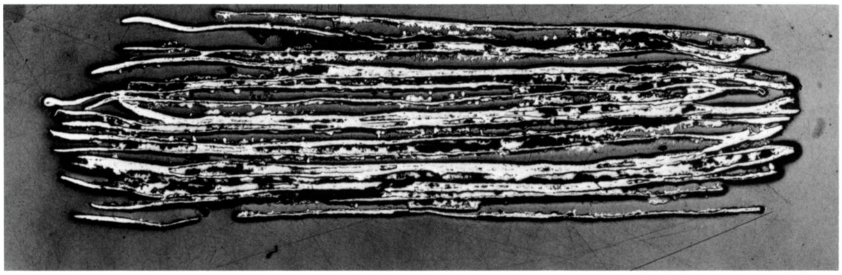


Fig. 43 Photomicrograph of a transverse cross section cut across the shank of the packet of Type 1b axe-monies, from Babahoyo, Ecuador, illustrated in Figure 11 (packet at far left of bottom row). The section runs across the entire width of the shank at its midpoint. There are 18 axe-monies in the packet held together, in part, by the corrosion products that have formed between them. The thickness of a typical leaf is 55μ (0.055 mm) at the center and 90μ (0.09 mm) at the thickened edges. Alloy: Cu-As; As varies from 1.2 to 2.5% in individual leaves. Magnification: 8. As polished (MIT 3453).

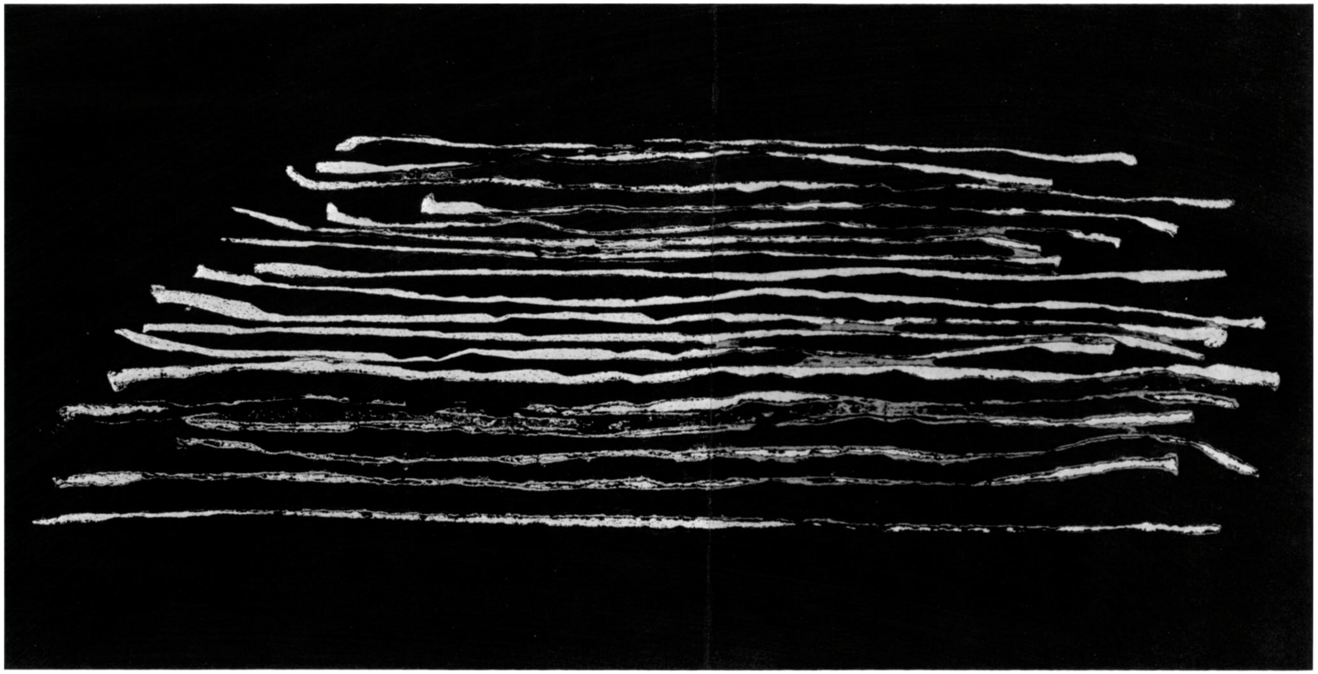


Fig. 44 Photomicrograph of a transverse cross section cut across the width of the shank of a packet of Type 1b axe-monies from Balao Chico, Ecuador. There are 18 individual leaves in the packet, some of which are almost entirely mineralized. Note the long and rectangular thickened edges on many of the leaves. Their form is almost identical to that of the Babahoyo axe-money illustrated in Figure 40. Alloy: Cu-As; As varies from 0.7 to 1.6% in individual leaves. Magnification: 7.5. As polished (MIT 3426).

tant to observe that in all cases in which Ecuadorian artifact types in metal were introduced to and later manufactured by West Mexican smiths—tweezers, open rings, needles—they were used in Mexico for purposes quite similar to those of their Ecuadorian counterparts (Hosler 1986, 1988c). Axe-monies are among such items, as Hosler (1986) has observed.

Peru

Naipes are not axes, nor do they resemble axes. Neither are they tools. The only alternative suggestion as to a possible semi-utilitarian function was made by Wassén (1972) in describing an object reported to be from a grave near Sipan in the Lambayeque valley. It consists of an array of 49 *naipes* held together with metal staples (1972: fig. 1). Wassén tentatively suggested that this composite might represent a portion of ceremonial plate armor; and Shimada, noting the Middle Sican occupation at Sipan, argues that "this object casts doubt on the monetary function of the *naipes,* although we must consider the possibility of money used ornamentally" (Shimada 1985a: 389). Pedersen (1976) strongly suspected that this piece was newly assembled from individual *naipes* that had issued from the Huaca Menor tomb. He argued, first, that no *naipes* except those comprising this object have perforations; second, that the object is built of a mix of the various subtypes of *naipe* he had recognized, whereas no such mixing exists in the original packets of Huaca Menor material (Pedersen 1976: 67). In 1973, before publishing his article, Wassén sent Lechtman a copy of the text, a photograph of the piece, and the chemical analysis carried out in Stockholm and later reported in his publication. This showed the substantial presence of zinc (0.79%) and the absence of arsenic and antimony (1972: 31) in the metal. On the basis of what was then known about the composition of copper alloy objects from the Peruvian north coast dating to the Middle Horizon and later, Lechtman replied: "As far as the chemical analysis is concerned, an unusual feature is the presence of zinc in low concentration. I have not found any zinc in the analyses I have carried out of Moche or Chimú period copper artifacts. . . . I have found that the copper of N. Peruvian artifacts of the Chimú period almost invariably contains arsenic and can be called arsenical copper. . . . My feeling is that the metal of which your object is fabricated is certainly atypical but not impossible for an artifact made during the preColumbian period" (Lechtman, 1973, correspondence with Henry Wassén). On the basis of the composition of Huaca Menor *naipes* reported here in Table 2 and of the analyses of those from the Huacas La Merced and Las Ventanas reported by Shimada (1985a: table 16.3), all of which are characterized by high concentrations of arsenic, trace amounts of antimony, and no zinc, it seems clear that the "*naipes*" in the piece in question are unlikely to have come from any of those sites and could well be modern forgeries.

We have not studied a sufficient number of *naipes* to comment upon standardization in production. The production material is uniformly copper-arsenic bronze with a relatively high arsenic contect. The average arsenic concentration of nine examples analyzed from the three *huacas* at Batan Grande (MIT and MASCA laboratories) is 3.55 weight percent, with a range from 2.45 to 4.47% (only one example fell below this range: 1.15%). This provides an interesting contrast with the Ecuadorian material. The 24 axe-monies from Ecuador reported here in Table 2 have an average arsenic content of 1.39 weight percent, less than half that of the *naipes,* with a range from 0.65 to 3.14%. An arsenic content of 3.6% would have imparted a pale pink color to the *naipes,* in marked contrast to the colors of silver (or a surface-enriched copper-silver alloy), gold, *tumbaga,* or copper itself. The Ecuadorian items would have looked much more coppery red.

In a certain sense one might argue that of all the artifact types with which we are concerned, *naipes* are most standardized. They occur in only one shape and exhibit the smallest range in size (range of lengths: 4.2–10.0 cm), with no miniatures reported thus far. All are made of thin sheet metal, hammered and annealed to achieve the singular form. Their edges are thickened, sometimes by upsetting, as the fairly thick (0.078 cm) example

from Vicus clearly demonstrates (Fig. 45). The microstructure of this *naipe* (3.57% arsenic) reveals extensive deformation of the highly segregated metal as it was hammered into increasingly thin sheet; but the *naipe* was left in an annealed condition once shaping was complete. Some of the Batan Grande *naipes*, considerably thinner than the Vicus specimen, exhibit areas of localized working subsequent to the final anneal. The thinner items are also observed to exhibit the central, oblong bubble. It may be that the bubble (a wave configuration in cross section) serves as a corrugation for the thin sheet, much as in the case of the thin Guerrero axe-monies, to provide rigidity.

We would not expect references to *naipes* in the ethnohistoric literature, since *naipes* are known archaeologically only from the Middle Horizon, associated with the Middle Sican presence in the Lambayeque valley from about A.D. 900–1100 (Shimada 1985a). They do not appear among the later Sican or Chimu cultural materials at Lambayeque or elsewhere: thus they were not saved or copied by later north coast dwellers. In spite of Shimada's urging that *naipes* be interpreted as primitive money (1985a: 358, 376, 386), that they constituted a medium of exchange and a standard of value in traffic between "Ecuador" and "Peru" (1985a: 390, 392; 1987a), and that the Middle Sican polity served as the hub of a grand maritime and terrestrial trade network which extended from Portoviejo in Ecuador to Chincha on the south-central Peruvian coast and which involved the production and distribution by Sican of *naipes* (and presumably other axe-monies) as the key item of exchange to keep this network operating (Shimada 1985a: 384, 391), we see a far more limited and even restricted presence for the *naipe*, geographically as well as temporally.

In assessing the cultural aspects of Sican copper metallurgy, Shimada (1987b) makes two salient points: first, that "an important part of the metallurgical production was directed towards this expanded and persistent funerary practice" (1987b: 20; translation by Lechtman) which included the interment in large numbers not only of *naipes* but of agricultural implements, spear points, *tumis*, and other presumed tools, all made of copper-arsenic alloy; second, because most of these copper alloy artifacts retrieved archaeologically are from burials, it is too early to estimate what portion of the total Sican production went for funerary purposes and what portion for other uses (Shimada 1987b: 20). Nevertheless, it is clear that "*naipes* had important cultural value and were differentially distributed and accumulated among different sectors of Middle Sicán society" (1985a: 386).

Of the various copper-arsenic alloy offerings buried in Middle Sican tombs—such as agricultural hoes and digging-stick points, knives, long spears or lance-like points, and *naipes*—it is only the *naipe* that is almost entirely restricted to the Lambayeque valley, with a modest presence we are just beginning to witness in the upper Piura region. All the other items are found in large numbers at least as far south as the Moche valley (Lechtman 1981), where they are also often reported as having been buried in surprising quantities. The *naipe* has not appeared in controlled excavations or as occasional or looted finds anywhere else in Peru or anywhere in Ecuador. On the basis of the evidence to date, we would argue that *naipes* were a clear and, it seems, a very special form of wealth among the Middle Sican; that they were an important symbol of status; that they were amassed in life for burial at death; and that they possibly served a ritual function as part of the elaborate burial custom of elite Sican society. There is no direct evidence, however, that they circulated outside of the Lambayeque valley complex. In the upper reaches of the Piura river—approximately 190 km north of the Lambayeque valley—*naipes* are reported as occurring only in the context of late Middle Sican shaft tomb burials, where they are present in modest numbers (Shimada n.d.b). The geographic restriction of *naipes* essentially to a single valley argues against their employment as primitive money or as items of exchange in the way that *hachuelas* certainly were in Mexico and that axe-monies are likely to have been in Ecuador. Furthermore, we wonder whether *naipes* circulated within Sican society itself as a standard of value or of exchange. They may have constituted a form of tribute, but they seem unlikely candidates for primitive money. In

speculating upon a report by Schaedel (n.d.) of a burial unearthed in Tumbes which contained "Lambayeque" vessels and Ecuadorian axe-monies (Shimada n.d.b: 9), Shimada poses the key problem: "It is not clear why ceramics, and not *naipes,* cross-cut the Peruvian-Ecuadorian cultural frontier that apparently existed somewhere between Tumbes and Piura" (Shimada n.d.b: 9). Merely to raise the question is to suggest its answer: *naipes* did not circulate and were not exchanged. They may have been too ritual-laden to move outside the burial context that bound them.

Shimada acknowledges that there is no direct and independent evidence that links the Sican *naipe* to the Milagro/Manteño axe-money (Shimada 1985a: 388–389). His argument that *naipes* "served as 'primitive money' is based on their similarity in form, material, and manufacturing to the abundant 'copper axe money' specimens . . . [from] coastal Ecuador" (Shimada 1985a: 386). The similarity in form is nonexistent; the similarities in the manufacturing material and in its processing are significant. Furthermore, the stacking, packeting, and burying or hoarding of these items in extremely large numbers is also an important common feature that *naipes* and feathers share with the Ecuadorian corpus.

The continuities we see from the Lambayeque valley to West Mexico are not continuities of form; they are continuities in metal usage and in the consequences of a thin smithing style of artifact elaboration. In terms of chronology, it is not yet clear whether the *naipe* and the feather as stack-packet items have precedence over the Ecuadorian axe-money, simply because we do not have the tight temporal control over the Ecuadorian materials that Shimada has for Batan Grande and for the Lambayeque valley as a whole. From the dates supplied by the Ayalan (Ubelaker 1981) and Loma de los Cangrejitos (Marcos 1981) excavations, one might well argue that the phenomenon of copper-arsenic alloy thin smithing and stack-packeting was roughly contemporaneous in the entire north Andean area, from Lambayeque to Manta. On the other hand, we are discussing objects and metallurgical styles of practice that arose in the central and north-central Andean zone, where it has been amply demonstrated that the metalworking tradition was overwhelmingly a sheet metal tradition (Lechtman 1980, 1988) and one of great skill and sophistication. The Moche and Lambayeque valleys were fountainheads of that tradition. What we see among *naipes* and feathers and, perhaps somewhat later, among axe-monies is a focus within the tradition which accorded special place to thinness: thinness in and of itself had value. One of the requisites of that system of value was apparently that it be expressed in objects made of especially thin sheet metal, and the metal had to be copper-arsenic alloy. If thinness is a value sought in production, then the amassing of metal or the hoarding of metal means the accumulation of large numbers of items, since wealth in metal was clearly reckoned by weight or mass.

The bulk form of thinness is the packet: the stacking, tying, and bundling of many individual leaves—leaves of *naipes,* leaves of feathers, leaves of axe-monies—was necessary to aggregate mass produced in the form of hundreds, thousands, tens of thousands of individual items which were too thin by themselves to maintain their integrity. Packeted, however, they assumed a new form, which, among other attributes, facilitates circulation and exchange. Such a system is quite different from one in which wealth is concentrated in a few or unique items, such as the cast giant Ecuadorian axes (Fig. 10), each made in a single pour.

The metal has to be an alloy because, as Hosler's studies have shown (1986, 1988a), the thin design requires a material strong and tough enough to survive thinness, the very quality of which the design is an expression. Here, in the selection and production of the alloy of copper and arsenic, the Middle Sican peoples made the single contribution that allowed the widespread development and use of thin-style smithing and of the range of objects that issued from it.

Thinness, as a quality of axe-monies and their relatives, disseminated as a value from south to north. Thin-style smithing, as equivalent to value, was undoubtedly a Sican export. Whether the copper-arsenic metal it relied upon was similarly exported from the Lambayeque valley to Ecuador, however, remains in question.

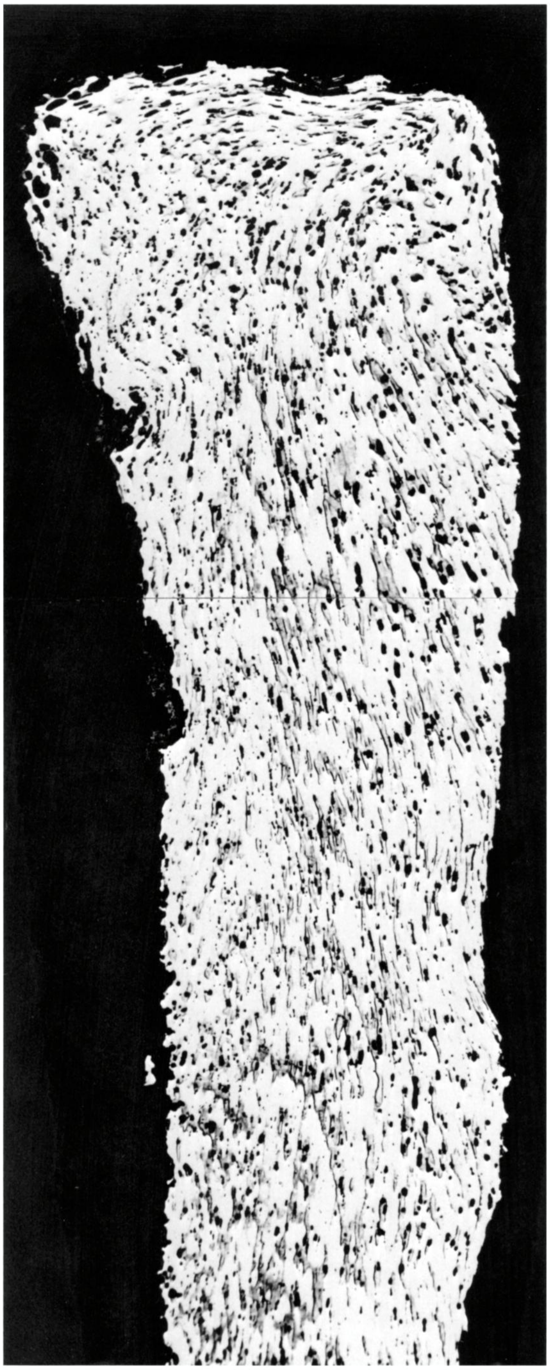


Fig. 45 Photomicrograph of a transverse cross section cut through one long side of the Vicus *naipe* shown in Figure 4. The section runs vertically from the upper edge of the *naipe* down to its midline, but only the thickened edge is illustrated here. The nonmetallic inclusions (possibly copper arsenates) are strung out in the direction of metal flow. Within the shank itself they are aligned parallel to the axis of the section, but near the thickened edge they become somewhat randomly ordered. At the edge itself the inclusions are aligned perpendicular to the axis of the section and to the prevailing orientation of the inclusions in the shank. This configuration is typical of metal that has been upset; the edge metal was hammered to compress it, thereby thickening the edge. The alloy (Cu, 3.57% As) is highly segregated. Although not evident in this photomicrograph, further etching brought out the fine structure, consisting of equiaxed grains with annealing twins. The microstructure of this *naipe* is different from that of most Ecuadorian axe-monies which are left in the worked condition. This piece has been left annealed. Magnification: 50. Etchant: potassium dichromate.

The Technologies of Exchange

This long review of the ethnohistoric, archaeological, and laboratory evidence pertaining to axe-monies and their relatives suggests that the phenomenon of the axe-money as an item with exchange value, circulating through one-to-one transactions as well as by tribute on a larger scale and at a higher organizational level, developed in stages. It seems to have had its technological beginnings in Lambayeque, was rapidly assimilated and transformed into something close to its final aspect by the growing chiefdoms of the central and southern Ecuadorian coast, and ultimately followed a maritime route to the Pacific coast of Mexico where it achieved its fullest expression. The features at the core of the complex that traveled from south to north were current during the Middle Sican presence at Batan Grande and remained invariant, in spite of the diversity of cultures and social systems that used and elaborated upon the core: (1) thinness as value (and the thin-smithing style as appropriate to production); (2) copper-arsenic alloy as the single and exclusive material for manufacture of objects; (3) stacking, tying and packeting of finished thin items into groups which are often bundled into larger aggregates and sometimes covered with cloth; and (4) hoarding of individual items, packets and bundles usually, but not exclusively, in burials. Several other features might be appended to the core, for example, the single-purpose use of the item, with the exception of feathers that were assembled in headdress arrangements and perhaps certain forms of Mexican axe-money that may have served double duty. The destination of items as tribute is another possible feature, although feathers seem more likely a status item of adornment ultimately collected as wealth, and the use of *naipes* in tribute is uncertain.

Value inhered as much in the copper-arsenic alloy and in the thinness of plate, sheet, or foil as in form. Indeed, form is not one of the core invariant features of the complex. But all the forms chosen for thin-style smithing had special cultural significance in the Andes and in Mexico—the axe, the feather, the mushroom, the llama. Only the *naipe* remains enigmatic in this regard.

Although we believe that the use of *naipes* as a medium of exchange is unlikely, it is clear that the packeting of *naipes* and of feathers in groups of ten or multiples of ten was translated in Ecuador to the packeting of axe-monies in standard sets apparently based on five or ten. The decimal system of accounting on the *quipu* was in place in the central Andes by the Middle Horizon (Conklin 1982), and it is no surprise to find a base-10 reckoning and, we might venture to call it, "storage" system functioning in a Middle Sican context (see, e.g., Netherly 1977: 307). In fact, Conklin has shown that certain complex Middle Horizon wrapped *quipus* use three information recording systems on a single *quipu:* base-five most frequently, binary systems next, and finally a base-10 system (Conklin 1982: 277). Prümers (n.d.) may be correct in suggesting that the numbers of leaves within packets or bundles of axe-monies had religious significance, but they may represent nothing more than an accounting device.

There is sufficient substantial evidence of exchange in elite goods between the Lambayeque valley and coastal Ecuador during the tenth and eleventh centuries to warrant the premise that such relatively frequent contact, maritime or terrestrial,

stimulated the transfer of the core axe-money complex to the Milagro/Manteño peoples from the Sican polity. Or it may be that the complex was current and contemporaneous throughout the northern Andean coastal zone, from Lambayeque to Manta, spurred by interregional exchange in elite items. Shimada (1985a) cites the presence of Sican ceramic ware on the Isla de La Plata, located off the central coast of Ecuador, between Salango and Manta, as well as the inclusion of "*Spondylus* shells, coral, emeralds, and various semi-precious stones [from Ecuador] . . . in Middle Sicán elite tombs" (1985a: 391), as indications that such traffic took place. Pedersen records the burial of large quantities of *chaquira,* made from shiny shell in red, white, and black colors in the huge tomb at the Huaca Menor (Pedersen 1976). If any of the items in that extraordinary burial possessed exchange value, *chaquira* did, and they could well have been made and brought in from Ecuador.

However, there is even more direct evidence, associated with metal items and with the production of metal, that bears witness to Sican-Milagro/Manteño contact. We have already mentioned the socket-end feathers (Fig. 19) excavated from the Cacique Guayas tomb at La Compañia, Los Rios Province, which are identical to others common to the Batan Grande area (Fig. 18). In that same tomb Meggers, Evans, and Estrada (n.d.) recovered a number of ceramic blowpipe tips (*toberas*) (Fig. 46) similar in form to those same items found abundantly at the metal production sites of Cerro del Pueblo, Batan Grande, and at the nearby processing sites of Cerros Sajino and Huaringa (Epstein and Shimada 1983: fig. 12; Shimada 1985a: fig. 16.5; Shimada 1987b: figs. 5, 6; Bray 1985: fig. 9). The Lambayeque *toberas* are refractory tips that were fitted to the ends of long hollow canes used as blowpipes in various stages of metal production: to raise the temperature of ore smelting furnaces in the extraction process and of charcoal beds in the crucible melting of metal, and in the annealing of objects during manufacture (Epstein and Shimada 1983; Shimada 1985a, 1987b). It seems especially telling that two items—*toberas* and feathers—so directly associated with Sican copper-arsenic metallurgy should be included in an important "chief's" burial of the Integration period. The feathers may even be imports from Lambayeque; the *toberas* are likely of local manufacture. Holm (n.d.) has collected many other examples of *toberas* from the La Tolita area of Esmeraldas, on the far north coast of Ecuador—not surprising in view of the considerable gold and gold-platinum metallurgy practiced there (Bergsøe 1937; Scott and Bray 1980)—but their dating remains uncertain.

Other metal items of copper-arsenic alloy attest to the close contact between the Lambayeque valley and the Ecuadorian coast during the period in question. Two types of heavy copper-arsenic socketed "points" common to the Lambayeque valley, made and buried there, and found buried in large quantities in the Moche valley as well (Lechtman 1981: figs. 10, 12, 15), are cited by Pedersen (1976: 63–64) as having issued from the Huaca Menor tomb, where they formed a considerable part of the 500 kg lot of "copper" burial offerings. The single "point" Pedersen illustrates (1976: 71, second drawing from top) is identical to one illustrated by Emilio Estrada (1954: grabado 40, object at bottom of illustration). The Ecuadorian example is associated with Milagro cultural materials, but Lechtman considers it an import from the Peruvian north coast. She has seen several other identical objects in the Museo de Arte Prehistórico de la Casa de la Cultura in Guayaquil. Finally, Meggers, Evans, and Estrada (n.d.) collected three objects, which we illustrate here in Figure 47, from burial urns originally interred in mound A at La Compañia and latter scattered over the surface of the site by bulldozer activity. Lechtman (1981: figs. 17, 18) illustrates similar examples from Peru, presently in the collections of the Museo Arqueológico Brüning, Lambayeque and the St. Louis Art Museum. Those analyzed thus far, including one of the La Compañia objects (see Table 2), are made of copper-arsenic alloy. We are uncertain about the use of these objects (referred to as tablets or *tabletas*), but their shape and the frequent incorporation of relief decoration in the form of a lizard on one surface are distinguishing characteristics. The Peruvian and Ecuadorian examples are close in all respects.

It seems clear that there was ample opportunity

for Milagro and Manteño peoples to have had access to and perhaps adopted the core axe-money complex from their Sican neighbors to the south. They elaborated it and eventually transmitted it to West Mexico. Shimada (1985a) has raised the matter of the source of the single raw material upon which all axe-money manufacture was based—copper-arsenic alloy (we refer to the alloy as arsenic bronze when the arsenic concentration is above approximately 0.5%, by weight). But an equally significant issue in the context of this discussion has to do with the circumstances behind the development of axe-monies as a medium of exchange within Milagro/Manteño society when a similar development appears not to have occurred in Sican, in spite of the presumed generation there of the core concepts and technological experience.

Shimada argues:

> there is a strong possibility that the Middle Sicán polity controlled production of a key medium of exchange/standard of value (copper-copper alloys) that is believed to have been used in an Ecuadorian-Peruvian exchange network. . . . we must explore the possibility that, in addition to producing the *naipes,* the Sicán polity exported the raw materials (blank sheets, ingots of copper and arsenical copper) to be processed further elsewhere; for example, on coastal Ecuador. (Shimada 1985a: 390, 392–393)

These suggestions must be considered in terms of what we know about the metallogenesis of the northern Andes, about the metals and alloys used by Milagro/Manteño peoples, and about their metallurgical technologies. In none of these areas do we have the rich fund of information that is available for the central Andean situation, but some data are beginning to set a context for Integration period metalworking.

Two alloy systems form the basis of Ecuadorian metallurgy during the period in question: copper-arsenic and copper-silver (Hosler 1986, 1988b). It is becoming clear that in Ecuador, between about A.D. 900 and 1400, by far the major proportion of objects made of copper alloys was manufactured from copper-arsenic metal. This is particularly the case for axes and axe-monies and for open loops or rings; but a few bells, needles, and occasional adornments were also made of the alloy (Escalera and Barriuso 1978). The widespread use of arsenic bronze was as common in the sierra as on the coast. Of 60 excavated copper-base objects from the Cañari-Inka site of Ingapirca in the southern highlands (Escalera and Barriuso 1978), all but one contain arsenic in substantial amounts: approximately 65% have arsenic concentrations ranging between 1 and 4%, 30% contain arsenic at the 0.1–1.0% level, and the remainder exhibit trace amounts of arsenic (0.01–0.1%). One tin bronze needle (9.7% tin) contains no arsenic, but a copper-tin alloy pin (3.5% tin) with round head does, indicating that tin in lower concentrations was added to arsenical copper. The objects analyzed from Ingapirca include loops, needles, *tupus,* bells, and various adornments.

Scott's analyses of artifacts from Ecuador support the findings from Ingapirca and broaden the range of analyzed artifact types we can include in the Ecuadorian corpus (Scott n.d.). His work concentrates on axes, the majority from the highland provinces of Azuay and Cañar. Except for those made of tin bronze, an alloy introduced by the Inka, all of the highland and coastal curved blade and flat blade axes Scott examined (33 items analyzed) are made of copper-arsenic bronze with arsenic present in the range of 0.5–4%, by weight. The only unalloyed axes he studied, from Pindilig, near Azogues, Cañar Province, are copper axes, many with gilt surfaces (Scott n.d.).

Our own analyses of axe-monies, curved blade axes, the four giant Milagro-Quevedo cast axes, several feathers (possibly from Lambayeque), and one *tableta* (without a lizard), all from the Ecuadorian coast, expand the geographic and typological spread in the Ecuadorian corpus of analyzed Integration period copper alloy objects. As Table 2 indicates, all the coastal items are made from copper-arsenic alloys.

All four laboratory studies—those of Hosler; Escalera and Barriuso; Scott; and Hosler, Lechtman, and Holm—leave no doubt that the alloy of copper and arsenic was the preferred material for a diverse range of implements, adornments, ritual items, and items of exchange, including axe-monies, used by coastal and highland peoples during the Integration period in ancient Ecuador. It was preferred not only for its mechanical proper-

ties, as a true bronze alloy, but for the silvery-pink to silver color the metal develops as the arsenic content increases (Lechtman 1988, and personal communication; Hosler 1986, 1988a). Is Shimada prepared to argue that all this metal used in the north Andean zone during the time in question was produced in Batan Grande, supplied and shipped by Middle and Late Sican polities (or even later by the Lambayeque Chimu)? That is what his suggestion (1985a, 1987a), cited earlier, would imply, given the analyses now available for a wide range of representative Ecuadorian objects, many of which are contemporary with *naipes* and with axe-monies.

Because our data on metal production technologies for Ecuador are meager, we cannot go far toward answering the very question we have raised: were north Andean societies mining, smelting, and extracting copper-arsenic metal from its ores, or were they importing the alloy from the south, where we know it was being produced in large quantities? Although ceramic *toberas* have not yet been reported from any workshop or smelting context within Ecuador, we can assume that they were used in melting and annealing metal, if not in the direct smelting of ores. Among coastal materials we have examined that are associated with metal production are four roughly plano-convex ingots and one artifact that may be described as a metal pour or run. Two of the ingots (Fig. 48) and the pour were among the items in the Cacique Guayas burial at La Compañia (Meggers, Evans and Estrada n.d.). The other two ingots were collected in Manabi. Given the shape and surface characteristics of the four cake-like ingots, they are more likely to be crucible products, formed by melting metal, than furnace smelting products, obtained in the extraction of metal from ore.

Metallographic examination of samples removed from all five objects (see Fig. 49) revealed the metal to be quite clean, with few nonmetallic particles of any kind other than occasional cuprous oxide (Cu_2O) and copper arsenate inclusions, lending support to the tentative identification of these ingots as crucible products. Interestingly, all five appear to have been cast from the same batch or similar batches of molten low arsenic copper-arsenic alloy. Table 2 indicates how tightly clustered the chemical analyses are, with arsenic concentration varying between 0.30 and 0.50%. This corresponds to the lower limits of copper-arsenic alloy composition found by Escalera and Barriuso (1978) in the Ingapirca material (30% of the objects they analyzed contain arsenic at the 0.1–1.0% level) and by Scott (n.d.) in the southern highland cast axes (Scott's analyses range from 0.5 to 4% arsenic).

The relatively low concentration of arsenic in these ingots provokes speculation about the source of the very broad spectrum of arsenic levels exhibited by copper alloy objects of the Integration period, running from 0.01 to 5%, by weight. Had smelted and refined stock ingots (or blanks, or sheet) of copper-arsenic alloy been obtained from the south by north Andean metalworkers for use in object manufacture, we would expect fairly tight clustering of alloy composition among the objects. Tight clustering would result, first, if some level of control had been exercised over the composition of the ingots at the production sites in the south before the metal was shipped north, and second, if north Andean smiths simply melted the ingots directly in order to cast certain objects or to provide blanks for the manufacture of sheet metal. The concentration of arsenic in the original stock ingots could be expected to drop appreciably only if such ingots were added to molten copper, thereby diluting the arsenic level of the resulting metal. Barring such dilution, the range of arsenic concentration exhibited by Ecuadorian objects could be expected to fall somewhere between about 1 and 4 weight percent, the likely and useful range of alloy composition of copper-arsenic bronze to be used in hammering objects to shape.

The composition range that characterizes the Ecuadorian corpus of objects is, however, considerably wider. Low arsenic alloys, containing between 0.1 and 0.5% arsenic, were quite commonly used, and about five percent of objects are made of arsenical copper containing trace amounts of arsenic (0.01–0.1%). This is the kind of composition array one would expect of metal won directly from its ores, especially copper-arsenic metal likely to have been manufactured by co-

smelting oxide ores of copper and sulfide ores of arsenic-bearing copper (Lechtman 1981, 1988; Hosler 1986, 1988a, 1988b). Such smelting regimes are known to produce a broad range of copper-arsenic alloy compositions, depending not only upon the quality of the ore but also upon the relatively oxidizing or reducing environment of the furnace. The low arsenic levels in the five Ecuadorian ingots presented here could easily have been produced in a direct co-smelting process: the initial furnace products would undergo refining to achieve the clean metal ingots we have examined.

If we concentrate on axe-monies alone, neglecting for the moment the wide variety of Integration period material culture in metal which serves as their context, and consider them a special category of object that might have been made from high-status, imported material—at least initially, before north Andean metalworkers learned to smelt the alloy from appropriate local ores—is there evidence to suggest that such material may have come from the Lambayeque valley? The set of histograms presented in Figures 50, 51a, and 51b is instructive in this regard. Each set is derived from the data on artifact composition given in Table 2 and plots the percentage of objects analyzed within any one group as a function of the concentration of arsenic in the alloys of which the objects in the group are made. In the case of the Mexican material (Fig. 50), the final histogram summarizes the analyses of 35 objects, integrating the data from the four subtypes studied. The final histogram for the Ecuadorian corpus (Fig. 51a) sums the data for 24 axe-monies and six relatives, 30 objects in all. Comparable statistics are not as good for the *naipes* (Fig. 51b), as we have available the results of only nine analyses with which to plot the histogram (5 objects reported here in Table 2; 4 objects reported by Shimada 1985a: 387). Nevertheless, as the Batan Grande *naipes* analyzed come from three distinct burial mounds—the Huacas Menor, La Merced, and Las Ventanas—we can assume that they are representative of *naipes* at the site.

The Mexican histogram can serve as a frame of reference, since we know Mexican metalworkers were smelting their own local ores—mixed ores of copper (likely chalcopyrite) and arsenic (likely arsenopyrite), which co-occur commonly in West Mexico—to produce copper-arsenic alloys (Hosler 1986, 1988a). The alloys used in the manufacture of axe-monies of all four subtypes cover a broad composition range, from several tenths of one percent to 6.5% arsenic, by weight. The large majority of objects is, however, made of a low-arsenic alloy: 40% fall in the 0.1–0.5% arsenic concentration range and 23% in the 0.5–1.0% arsenic range. The latter group can be considered arsenic bronzes. There is a fairly uniform but low distribution of objects in the alloy concentration ranges that begin at 1% and increase to 6.5% arsenic. Clearly, most of the Mexican artifacts are made from metal smelted from a mixture of copper and arsenic minerals. Upon direct smelting, such ores yield alloys with relatively modest but significant concentrations of arsenic from the point of view of their mechanical properties.

The histogram for the Ecuadorian material departs somewhat from the Mexican picture. Here there is a general shift towards higher arsenic concentrations, the bulk of all objects falling between the 0.5 and 2.5% arsenic levels. Interestingly, none of the Ecuadorian axe-monies we have analyzed thus far contains less than 0.5% arsenic. Aside from the generally higher values of arsenic in the Ecuadorian corpus as compared with the Mexican group, the overall trend of the north Andean plot is similar to that of the Mexican: the large majority of objects falls within the 0.5 to 2.0% arsenic concentration range, and thereafter there is a rapid falloff of items as arsenic concentration increases.

Even in spite of the far smaller number of *naipe* analyses available for the plot of Figure 51b, the shape of the *naipe* histogram is almost the mirror image of that corresponding to the north Andean corpus of objects and, similarly, presents the reverse of the Mexican array. Thus far, no *naipes* have been studied whose arsenic concentration is below one weight percent, and the bulk of these objects (78%) are made of alloys with quite high arsenic concentrations, running from 4 to 5%, by weight. It is difficult to assess to what extent the *naipe* histogram may be affected by the relatively small number of objects analyzed, although in the

case of the Ecuadorian material there are only 11 Type 1a axe-monies and 11 Type 1b axe-monies represented in each of the two upper histograms plotted in Figure 51a. The *naipe* histogram can be compared with either of those in terms of statistical meaningfulness.

What is striking about the *naipe* histogram is not only its dramatic difference from those of the northern Andean zone and of Mexico, but its clear departure from the histograms published by Lechtman (1981: fig. 38) for a group of 50 copper-arsenic alloy objects, both cast and worked to shape, from the region between the Moche and Lambayeque river valleys on the north coast of what is today Peru. Many of these objects are contemporary with *naipes*. The data show a fairly continuous range of arsenic concentration among all the objects, from a low of a few tenths of one percent to a high of six weight percent. Lechtman concluded (1980, 1981) that these alloys were made by the direct smelting of arsenic-bearing copper ores.

No *naipes* were available for study at the time the analyses of the Peruvian north coast material were carried out. The analytical results reported here in Table 2 and Figure 51 thus allow consideration of how the *naipe* relates to this large variety of north coast arsenic bronzes. Though relatively few in number, these results strongly suggest that, unlike what obtains for most other objects of the period in question, a high arsenic alloy was deliberately selected at Batan Grande for the manufacture of *naipes*. It is, however, nowhere evident that that same high-arsenic alloy was shipped north, and for a similar purpose. There are few north Andean axe-monies made of such alloys (see Fig. 51a). On the contrary, most never reached an arsenic content greater than 2.5%. Whether such high arsenic alloys, produced in Lambayeque, were added to molten copper by Ecuadorian smiths to achieve alloys of lower arsenic content is certainly a possibility, but the data thus far available do not lead to that conclusion.

One of the several arguments Shimada cites (1985a: 388; 1987a) in support of his suggestion that arsenic bronze metal was being shipped in ingot or semi-processed form from Lambayeque to coastal Ecuador is the absence of any ore mineralization on the Ecuadorian coast. His interpretation of Ecuadorian geology and ore mineralogy is based on a passage in which Holm assessed the possible sources of raw material for the manufacture of coastal "copper" money-axes in the prehistoric era.

> . . . we do not know of any copper ore, or native copper deposits, within this [Milagro-Quevedo] cultural area, nor are they likely to be found as the territory consists mainly of fluvial and alluvial plains of fairly recent formation. . . . The nearest available deposits seem to have been those of the Andes highlands, east of the Milagro-Quevedo area, more specifically in the present Cañar and Azuay provinces . . . The foreign [i.e., highland] origin of the raw material, the copper, would of course tend to be a stabilizing factor in the value of the money-axes. (Holm 1966/67: 140–141)

In a later publication about axe-monies Holm (1978: 352) refers to the zones around Toachi and Macuchi, on the western slopes of the Ecuadorian Andes, as containing copper, silver, and gold ores which were exploited during the Colonial period and on a small scale during World War II; but, he notes, we do not know if these ores were mined prehistorically.

The results of the recent laboratory analyses of axe-monies and of a wide variety of other copper-alloy objects from ancient Ecuador allow the formulation of much more focused questions concerning the raw materials from which such objects were made. The question for geology is whether the geologic environment and the ore mineralogy of Ecuador are similar enough to those of northern Peru that both regions could be expected to yield the same variety of ore minerals which ancient miners might have encountered. The question for archaeology is whether prehistoric miners in the area of modern Ecuador could have mined or did mine ores that, upon smelting, would produce copper-arsenic alloys.

An answer to the geological question can be found by comparing recent metallogenic maps for Ecuador (Paladines and Sanmartín 1980) and Peru (Ponzoni 1969). The maps indicate that, mineralogically and geochemically, the two regions are quite similar. The ore minerals and their geologic

setting (host rocks) are not significantly different within the areas represented by modern Ecuador and Peru. The same basic geological makeup and the same types of ore deposits occur in both areas, arranged within zones that run roughly north-south, following the Andean cordillera. Several of those zones, of interest to the discussion here, are:

1. Metamorphic rocks in the highlands and eastern slopes of the Andes run continuously from Peru into Ecuador. This is a zone in which placer gold deposits are found in both regions.
2. Mesozoic rocks in the highlands containing tertiary intrusives and ore deposits of copper, lead, zinc, silver, and gold also run continuously from Peru into Ecuador.
3. Volcanic fields in the highlands, overlying the Mesozoic rocks, contain copper, silver, gold, and lead-zinc deposits in both Peru and Ecuador.
4. Igneous intrusive rocks in the highlands and western slopes of the Andes contain porphyry copper deposits in Ecuador, a continuation of the same zone in Peru. For example, the disseminated copper deposit at Chaucha is like Peruvian porphyry copper mines at sites such as Michiquillay (Petersen 1970) and Turmalina (Ponzoni 1969).

The area described by Holm in the passage cited earlier (1966/67) is characteristic of Ecuador and is not found in Peru. It is limited to the south-central coast, roughly from the latitude of Guayaquil to that of Portoviejo further north. The basaltic rocks in this zone were once part of the ocean floor, and there are no important ore deposits here. Thus all the ores of consequence in Ecuador are in the highlands.

Metallogenic maps may be misleading, however, and must be interpreted with care, as they tend to list the modern, commercially mined metals at a site, often ignoring the basic mineralogy of the area. The large mineral deposit at Pillzhum is a good example. The 1980 Mapa Metalogénico del Ecuador (Paladines and Sanmartín) designates this as a AgPbZn (silver-lead-zinc) ore body, as those are the primary economic metals presently in exploitation. But Sauer (1971: 236) accounts for the basic mineralization at Pillzhum thus: "A Cu-Ag-As formation . . . with enargite, tetrahedrite, and proustite as the primary minerals; with bornite, covellite, and chalcocite as secondary minerals. Galena and sphalerite occur in unimportant quantities." Ulrich Petersen (personal communication, 1988) interprets Pillzhum as essentially an enargite (copper sulfarsenide: Cu_3AsS_4) ore deposit, like those at Hualgayoc and Quiruvilca, or many of the other major Peruvian mines located in the highlands further to the south that are rich in arsenic-bearing copper sulfarsenide minerals.

Thus not only do we find the same general ore deposits in Ecuador as in Peru, but the kinds of copper-arsenic ores that are characteristic of Peru, especially abundant in the central and northern highlands, are also characteristic of the Ecuadorian sierra. Lechtman (1976, 1981) has argued that the arsenic-bearing copper ore likely to have been smelted in the Moche-Lambayeque area as the primary source of arsenic in the production of copper-arsenic alloys is enargite, the sulfarsenide of copper so plentifully found in the highlands of the Jequetepeque valley and the mountains to the north. As we see, this same ore type is available in Ecuador.

The issue of whether the Ecuadorian copper-arsenic ores were mined prehistorically turns, in part, on the quantity of ore that is potentially exploitable and its accessibility (see Goossens 1972a, 1972b). Based on his thorough knowledge of the metallogenesis of the entire Andean zone (Petersen 1965, 1970, 1972), Ulrich Petersen believes that most of the ore deposits in Ecuador were not discovered until rather recently because of the vegetation cover over much of the area (U. Petersen, personal communication, 1988). Unless the mineral deposits occur at high altitudes so that erosion exposes them, or in desert conditions, like those along the Peruvian coast, where they may also be visible for lack of soil and vegetation cover, ores are difficult to find because they do not crop out. The extensive deposits at Chaucha, for example, were not discovered earlier because of the extent of the vegetation in the area, and this condition in the Ecuadorian sierra holds true as far north as La Plata in the highlands of Cotopaxi Province. In the most northerly sector of Peru,

where the dense vegetation cover in the highlands resembles that of the Ecuadorian sierra, the porphyry copper deposits recently discovered on surveys run by the Peruvian government were not seen before because they were covered over (U. Petersen, personal communication, 1988). At Hualgayoc, by contrast, the extensive enargite deposits are exposed because the ore is at a high elevation (ca. 3800 m) (Ericksen, Iberico, and Petersen 1956; Cabos 1982; Vidal and Cabos 1983).

The situation with respect to Ecuadorian mining, whether prehistoric or contemporary, rests neither on the kinds of ores available nor on the extent of the ore deposits; sufficient amounts of copper and copper sulfarsenide ores are present. It has to do rather with their identification and accessibility. We will not know whether such ores were mined during the Integration period until careful geological and archaeological surveys have been carried out in those highland zones potentially most likely to have been exploited. Pending that fieldwork, the issue of the wholesale movement of copper-arsenic alloy metal from the Lambayeque valley to the north, in the considerable quantities in which we can now reckon its passage, is likely to remain unresolved. On the other hand, studies of lead isotope ratios of typical copper and arsenic-bearing copper ores from Peru and Ecuador can help establish the geographic distribution and possible clustering of those ratios (Marcet, Petersen, and Macfarlane 1987; Macfarlane and Petersen n.d.). It may then be possible to seek correlations between the isotope ratios of the ores and those of the objects with known Peruvian or Ecuadorian provenience. We are planning a pilot study of this kind to test its usefulness in clarifying the source of the ores, and therefore of the metal that constituted wealth among such a diversity of societies in the north Andean area.[13]

Although at present the nature of Ecuadorian mining, smelting, and metalworking activities during the Integration period is entirely open, we know from Hosler's research (1986, 1988c) that the technical knowledge behind mining, the production of alloys, and the fabrication of metal objects was transmitted to West Mexican societies in large part through their direct maritime contacts with peoples from Ecuador. The breadth and sophistication of the technologies imparted could hardly have issued from metalworkers whose exposure to metal was limited to the melting and working of stock copper-arsenic alloy obtained from the south. In whatever form and at whatever scale Ecuadorian metallurgical activities may have proceeded, we can use the result of those activities—wealth in copper-arsenic metal—to explore a larger issue: the circumstances within which transactional arrangements, based on ascription of exchange value to conventional forms of wealth, developed alongside the accumulation and hoarding of that wealth. If we are correct in arguing that *naipes* were not axe-monies primarily because, though hoarded, they did not circulate as items of exchange, what factors within the Ecuadorian experience stimulated the use of axe-monies in that mode?

The appearance of axe-monies outside the core Milagro-Quevedo culture area, such as at Tumbes and Talara (see map, Fig. 13), is the result of active traffic by these coastal peoples who sailed balsa wood rafts south to what is today northern Peru, and north as far as Mexico. If we consider just the inventory of natural and cultural materials from Ecuador common to elite Middle Sican tombs in the Lambayeque valley—emeralds from the Esmeraldas region of the far north coast, *Spondylus* shell, *chaquira* often worked from *Spondylus*—we have one example of the extent of this maritime activity which already had considerable chronological depth by the onset of the Middle Horizon in the central Andean area.

[13]Ulrich Petersen of Harvard University joins us in this work. We have begun by characterizing the lead isotope ratios of copper ores from the north coast and north highlands of Peru. Next the isotope profiles of copper-arsenic bronze objects from the Peruvian north coast cultures will be determined and compared with those of the ores. The Peruvian material will be studied with care to evaluate (1) how successfully we can differentiate between highland and coastal ores and (2) whether, upon study of the alloys, we can determine the geographic zone from which the ores derived that produced those alloys. Only then will we consider the Ecuadorian material. Andrew Macfarlane, a recent recipient of the Ph.D. degree in geological sciences at Harvard, initiated the lead isotope analyses while working as a research fellow at the Center for Materials Research in Archaeology and Ethnology at MIT.

The Ecuadorian scholar Jacinto Jijón y Caamaño, with his profound knowledge of his country's prehistory and ethnohistory, coined the expression "*liga de mercaderes*"—league or confederation of merchants—to describe the economic activities and political relations among the Pre-Columbian chiefdoms of the Ecuadorian coast, with specific reference to the Manteños and Huancavilcas (Jijón 1941: 2: 91–92, 101). The extensive maritime traffic in which these peoples engaged became a historical fact in 1526 when Bartolomé Ruiz de Estrada, Francisco Pizarro's chief pilot, encountered a native South American seagoing balsa wood raft near Punta Galera, as it sailed northward along the Ecuadorian coast. The home port of the vessel may have been the ancient town of Salango[14] or one of the other towns on the central coast of Ecuador (see map, Fig. 8) that figured in the Manteño *señorío* (dominion) of the Lord of Salangone (Oviedo y Valdés 1945; Jijón 1940–1947: II: 87–103; Marcos 1978; Norton 1987). Ruiz called the vessel a "*navío de tractantes,*" a merchant vessel (Oviedo y Valdés 1945: 11: 220–221). Having captured it, he not only described its crew and the merchandise on board (it had a 30-*tonel* capacity), but also as a sailor commented upon its construction and rigging (Oviedo y Valdés 1945; Sámano-Xerez 1937: 65–66). Made of large wood logs lashed together, the raft featured cotton sails, masts, rigging made of a hemp-like cordage, and rudders. Its cargo of elite goods included a wide variety of objects of gold and silver, richly decorated cloth of many colors, mirrors framed in silver, emeralds, balances with small weights for weighing gold, and much more. And all this, Ruiz reports, was being transported north to exchange for a type of sea shell, from which white and orange colored beads were made—and the vessel was full of such beads. Ruiz described *chaquira,* tiny white-orange and reddish orange beads made from *Spondylus* shell.

There is by now a considerable literature about the large Ecuadorian balsa wood sailing rafts, steered by moveable center boards (*guaras*) and with a Marconi-rigged sail, such as the one Bartolomé Ruiz intercepted and which we find frequently described by the early chroniclers (E. Estrada 1955; Edwards 1965; J. Estrada 1988). Smaller versions continue in use as riverine fishing vessels in the Ecuadorian provinces of Guayas and Los Rios (J. Estrada 1988) and off the far north coast of Peru, in the Department of Piura (Sabella 1974). An even more impressive literature has built slowly about the single item—*Spondylus* shell—whose acquisition and exchange was vital to these long-distance voyages that eventually linked a network of actors, from Mexico to south-central Peru (Holm 1953; Murra 1975; Paulsen 1974; Marcos 1978; Norton 1987; Cordy-Collins n.d.).[15]

As early as 1953 Holm pointed to the close connections among *Spondylus,* balsa wood, and the development of a sophisticated technology of raft building and of open-ocean navigation among the coastal populations of prehistoric Ecuador. The warm tropical waters that hug the Ecuadorian coast provide a natural habitat for the two varieties of the seashell, *Spondylus princeps* Broderip (the "thorny oyster") and *Spondylus calcifer* Carpenter, that were exploited and disseminated by Ecuadorian coastal dwellers.[16] Equally important to the widespread maritime traffic in *Spondylus* was the

[14]Joan de Sámano (Sámano-Xerez 1937) identifies several of the sailors captured from the raft as from the "pueblo de calangome": ". . . en aquel pueblo de calangome donde ellos son hay cuatro pueblos juntos todos de un señor que son el dicho calangome [Salangone] y tusco [Tuses] y çeracapez [Seracapez] y çalango [Salango] . . ." (1937: 68). Presley Norton believes that the ancient city of Salango corresponds to the large urban center whose remains extend over two small, adjacent *bahías* located opposite the Isla de Salango and slightly to the south of the modern town of Salango (Norton 1987). The port of embarkation of the captured raft could have been this coastal site or one of the others, slightly farther north, which Norton has identified on his surveys of the area.

[15]Care is needed when reading sixteenth-century and even later accounts of indigenous methods of ocean navigation, because Spaniards used the word "*balsa*" whenever they observed a craft which was neither a European vessel nor a native canoe. It made no difference to them if the vessel was a raft constructed of balsa wood logs, a net filled with dried gourds, a small craft formed by uniting two inflated sea lion skins with a wooden board on top, or even a "*caballito de mar,*" the Peruvian totora reed fishing craft. All were *balsas.* Balsa, the timber, became synonymous with any seagoing vessel. (The same equivalence was made with the Brazilian *jangada* and the timber used in its construction.)

[16]The natural habitat of both types of *Spondylus* is the offshore waters from the Gulf of Guayaquil to the Gulf of California (Pacific coast of Mexico).

availability on or just inland from the Ecuadorian littoral of a complex of materials essential to the construction of ocean craft that would survive long voyages on the open sea. Balsa wood (*Ochroma* sp.) was chief among these, but bamboo, cotton for sails, and a smooth and extremely resistant reed, which Bartolomé Ruiz referred to as "*henequen*" (hemp) used for cordage and lashings (Zevallos M. 1988), were equally vital to raft construction and were in plentiful supply on the Ecuadorian coast. Balsa wood as a botanical species is found from southern Veracruz, Mexico to the jungles of eastern Bolivia. It requires moisture and sunshine, and consequently is completely absent along the coastal desert of Peru and Chile. It grows abundantly along the humid tropical Pacific coast of Ecuador. As it is a self-sowing tree, a field abandoned through the practice of slash and burn agriculture, for example, turns quickly into a solid stand of balsa. When crowded, balsa can reach about 10 m in height and attain a diameter of some 10 cm within a few years. Trees in more open stands reach a diameter of 25-30 cm in five to eight years, and old trees have been reported with diameters up to 1.2 m (United States Department of Agriculture, Forest Service 1947). The logs are straight, of low density, and, when green, will continue to float for well over a year (Heyerdahl 1955). They were the primary construction material for the large sailing rafts of the Manteño and Huancavilca chiefdoms.

There is now abundant archaeological evidence attesting to the early use of *Spondylus* in coastal and highland Ecuador from about 3000 to about 1100 B.C. (Paulsen 1974; Marcos 1978). The Early Horizon in the central Andean area saw the introduction of the shell from Ecuador and its considerable use both in the highlands and along the coast of present-day Peru. From the Middle Horizon forward, however, the central Andean demand for the shell increased dramatically, and it was supplied in vast quantities to the Inka state (Murra 1975; Marcos 1978). Thus by about A.D. 900, at the beginning of the Integration period in Ecuador, suppliers of *Spondylus*—coastal peoples with a highly developed nautical technology—met the increasing demands from the south not only through exploitation of the shell beds off their own shores but also by sailing north to obtain new sources of supply, probably from Mexico or via trade partners in Panama (Marcos 1978). Such was evidently the purpose of the vessel taken by Bartolomé Ruiz. Whether or not the powerful Manteño/Huancavilca chiefdoms had formed some sort of political unity or economic organization of merchant ports such as the league suggested by Jijón y Caamaño, it seems clear that these sailors controlled the source of *Spondylus* that had become a vital ritual and political item throughout the central Andes, and that they dominated the traffic along extensive stretches of the Pacific littoral for more than half a millennium (Marcos 1978; see also Pease 1978: 98–99).

As we have already noted, not all the precious or exotic materials transported by Manabi sailors along well-used maritime networks had exchange value or may have served as primitive money. *Chaquira* probably did, and we expect axe-monies did also, though they did not travel so far. The transactional aspect of the axe-money developed within the context of a society engaged in active long-distance traffic, by preeminent seafarers with an intense maritime exposure stimulated by exchange. The material itself—copper-arsenic bronze—had inherent value, and the form which expressed that value was bound to a widespread cultural commitment to the axe as a signifier of wealth, status, perhaps political acumen, and the cementing of social relations. The difference between *chaquira* and axe-money, as is evident from the archaeological record, is that *chaquira,* like unworked *Spondylus,* moved far to the south, well outside of equatorial waters (Murra 1975; Paulsen 1974; Marcos 1978; Marcos and Norton 1981; see also Netherly 1977: 266–269); axe-money did not. In the Andean region, axe-monies are widely dispersed within the Milagro-Quevedo/Manteño-Huancavilca geographic limits and occasionally beyond those limits. But they do not appear at Lambayeque. Perhaps that would have been bringing coals to Newcastle.[17]

[17]We wish to be quite clear that in associating Bartolomé Ruiz' "merchant vessel" and Jijón's "league of merchants" with

When we look north from Ecuador to Mexico, however, the picture is quite different. Metallurgically speaking, the southern portion of what is today Ecuador can be considered the northernmost limit of the central Andean technological style of handling metal (Lechtman 1988). The same alloy systems and the same overall commitment to a tradition of shaping metal by working it were current there as they were to the south, where these alloys and manufacturing traditions developed. Because of their pivotal role in Pacific maritime exchange, at the center of a long-distance network that specialized in the acquisition and distribution of *Spondylus* shell (Holm 1953; Murra 1975; Paulsen 1977; Marcos 1978), the powerful chiefdoms of the Manabi coast were in a position to transmit more than goods to West Mexico, the most northerly outpost in the maritime chain (Fig. 8). Hosler's recent study of the origins, technology, and social construction of West Mexican metallurgy (1986, 1988b, 1988c) attests unequivocally to the historical relations between West Mexican metallurgy and that of Ecuador. She further demonstrates that the technological underpinnings of West Mexican metallurgy were transmitted in large part from southern Ecuador via a maritime route. Ecuadorian peoples, receiving technological traditions from the south, conveyed them north.

Hosler plots the development of West Mexican metallurgy in two stages, each of which corresponds to specific influences from metallurgical culture areas to the south—initially from Ecuador, Colombia, and Central America, and later from those same regions but also including southern Peru and Bolivia (Hosler 1986, 1988b, 1988c). The introduction of the axe-money complex belongs to the second of these stages. During the initial period, which corresponds to the establishment of metallurgy in West Mexico (approximately A.D. 800 to A.D. 1200–1300),

> the resemblance with the metallurgy of southern Ecuador is most striking. In West Mexico during this time, bells, needles, open rings, and depilatory tweezers, as well as axes, awls, and occasional fishhooks constitute the basic constellation of objects made from metal. In southern Ecuador during and prior to this period, metal was used to fabricate *this same inventory of objects that exhibit the same design characteristics and the same fabrication techniques*. (Hosler 1988c: 835)

The principal metal used in West Mexico at this time was copper; silver and gold were also occasionally employed. In the case of some object types, such as open rings and depilatory tweezers, the archaeological context, and presumably the social function, of these items is identical in southern Ecuador and in West Mexico. Hosler argues that the same correspondence is likely true of the other artifact types (1986, 1988c). At the same time, she is careful to point out that the West Mexican objects are not exact replicas of their Ecuadorian counterparts, which served as prototypes for objects subsequently manufactured locally. "It seems clear that, for the most part, it is knowledge—not objects—that was imparted [to West Mexico], knowledge of smelting technologies, of mineral and ore types, of fabrication techniques, and of the kinds of objects that could be made from metal, which were, of course, those very objects that were produced in Ecuador and Colombia" (Hosler 1988c: 843).

Although axe-monies or the axe-money complex were not among the inventory of objects and uses of metal that reached West Mexican shores on this first wave of metallurgical experience, it is important to sense the quality of that experience. For example, a 1525 document from Zacatula, near the mouth of the Balsas river in Mexico, describes what may well have been an Ecuadorian trading expedition there. The Indians in the region told the Spaniards that their grandfathers and fathers had traded with mariners bringing rich cargoes from the south in large canoes ("*grandes piraguas*"), and that these traders sometimes spent five to six months in West Mexican ports (West 1961: 133). There was adequate time

axe-monies no argument is being made that Manteño/Huancavilca navigators were trading for economic gain. We read the sixteenth-century Spanish *mercar* and *mercader* as signifying Andean forms of exchanging one set of items for another, each of which probably had a different set of values. Social and political prestige, scarcity, religious or ritual value, and the material nature of the items themselves (cloth, metal, shell; color, texture, form) must have represented the standards of measurement.

for Manabi sailors, traders, and presumably metalworkers to share cultural attitudes, material culture, and technological know-how with peoples in West Mexico.

It is not surprising, then, that during the second period of elaboration of West Mexican metallurgy, when the axe-money complex was introduced from southern Ecuador, it took root and developed rapidly along its own lines. In Hosler's view, the greatest similarity within all categories of material culture between West Mexico and the Andes occurs in the axe-money. That is certainly true for material culture in metal. In at least one case the forms elaborated in the two regions are extremely close (West Mexican Type 3a and Ecuadorian Type 2), and Ecuadorian axe-monies may have travelled north on Manteño balsas. There was a common conceptual currency surrounding these objects that was shared by both culture areas.

The period when the axe-money complex was introduced to West Mexico is of particular interest because of its near contemporaneity with the entry upon the scene of Chincha as a major actor in Pacific coast, long-distance maritime traffic in the central and north Andean zone. Hosler sets the second period of West Mexican metallurgical development as spanning A.D. 1200–1300 to A.D. 1525 (Hosler 1986, 1988b). The basic technological repertoire that had defined the metallurgy earlier expanded dramatically, especially in the utilization of alloys of copper for the manufacture of many objects; copper-silver, copper-arsenic, and copper-tin were the three binary alloys employed. New artifact designs appeared—such as tweezers made from extremely thin metal with blades of double curvature (shell tweezers) and loop-eye needles, as distinct from the earlier perforated-eye needles—which were subtypes of previous artifact types but whose form and function required the mechanical properties conferred by the alloys (Hosler 1986, 1988a, 1988c). Several completely new artifacts appeared in the West Mexican corpus at this time as well: copper-silver sheet ornaments, lost-wax cast ornaments, and axe-monies. As we have seen, the alloys of copper and silver and of copper and arsenic (arsenic bronze) were already in widespread use in northern Peru and southern Ecuador; the technical aspects of their production and handling were almost certainly transmitted to West Mexico from Ecuador along maritime channels long in use. As in the first period, the most direct connections we can observe between West Mexico and South America at this later time occur with coastal Ecuador. Striking cases are found in the use in both regions of copper-silver alloys for sheet metal ornaments that are often virtually identical with respect to dimensions, fabrication techniques, and material, and in the abundant use in West Mexico of copper-arsenic alloys for two common types of Ecuadorian artifact: axe-monies and loop-eye needles (Hosler 1986, 1988c).

On the other hand, the appearance in West Mexico during this second period of yet other artifact designs and of the alloy of copper and tin (tin bronze) provides the best evidence of contact with the south-central coast of Peru and the adjacent Andean highlands. For example, certain West Mexican shell tweezers are exact replicas of tweezers found only in southern Peru; they are absent in the intervening area. Other artifact types, such as tin bronze loop-eye needles, which were not made in the north, are identical with respect to form, fabrication technique, and material in southern Peru and in West Mexico (Hosler 1986, 1988c). Tin bronze is a south Andean alloy, knowledge of which reached West Mexico from the south-central Andean area.

The existence of a more southerly arm of the Andean long-distance maritime exchange network, which connected Ecuador with southern Peru during the Integration period, was revealed in 1970 by María Rostworowski. She published a mid-sixteenth-century Spanish document that discusses Chincha, a large and wealthy kingdom on the south-central coast of Peru (see map, Fig. 8), which flourished during the Late Intermediate period (ca. A.D. 1000–1476) and continued as a major economic force into the Late Horizon (A.D. 1476–1532). According to the document, Chincha was an active port in which resided six thousand "merchants" ("*mercaderes*") who engaged, perhaps full time, in long-distance maritime trade with points north, using fleets of balsa rafts (Rostwor-

owski 1970: 150–151).[18] The document specifically names Quito—that is, the Audiencia de Quito, the territory which corresponds approximately to the modern Republic of Ecuador—as the destination of the goods these balsas carried, and cites Portoviejo, a town which is today slightly inland from the Manteño seacoast capital of Manta, on the central Ecuadorian coast, as one of the ports of call. The document does not state explicitly that *mullu* (*Spondylus* shell) was brought to Chincha from Ecuador, but we may safely infer that it was, and undoubtedly in large quantities. It mentions *chaquira de oro* and emeralds as precious items transported to the south. It makes no mention, however, of what traveled north from Chincha, in exchange. Bartolomé Ruiz' description of the cargo aboard the large northbound sailing raft he intercepted off Punta Galera—just south of Esmeraldas, on the far north coast of Ecuador—provides some of that evidence. Among the metal objects listed on board are silver and gold crowns, tiaras, tweezers, bells, and bands (Sámano-Xerez 1937: 65–66). Copper objects are not listed, but the Spaniards may not have thought them worthy of mention.

Chincha emerged as a powerful coastal state at approximately A.D. 1200, and during the Inka hegemony was allowed to continue its activities because of its key position in the flourishing Pacific coast network. The active functioning of as important a maritime exchange organization as that centered at Chincha plausibly explains how artifacts such as south coast shell tweezers, as well as knowledge of the south Andean tin bronze alloy, could have been transmitted to West Mexico. Though the distances are great, such objects were probably transshipped by Ecuadorian traders to the north—together with axe-monies, copper-silver sheet artifacts, loop-eye needles, and so forth—through Colombian, Costa Rican, and eventually West Mexican ports (Hosler 1986, 1988c).

The Chincha document is of particular interest to any discussion of axe-monies, because it states that in all of *Tawantinsuyu,* only the merchants of Chincha used money ("*moneda*"); they bought and sold in copper (Rostworowski 1970: 171), apparently using copper as a value for exchange. Furthermore, each copper token or item of currency ("*marco*") had a fixed value (Rostworowski 1970: 171).[19] Rostworowski (1988) speculates about the form in which such copper was transported, as she argues that it was chiefly copper, which she believes the Chincha merchants obtained from the southern highlands and *altiplano* (Rostworowski 1970), that was the primary good they shipped north to exchange for warm-water *mullu.* Oberem and Hartmann echo this conclusion (1982: 147). "Is there the possibility, which has not been established archaeologically, that they [the Chincha merchants] manufactured so-called "axe-monies," similar to those in Ecuador, and that these were used for purposes of exchange?" (Rostworowski 1988: 279; translation by Lechtman). To date, no copper or copper alloy objects resembling *naipes* or axe-monies have been found south of the Lambayeque valley, nor have any other artifacts been uncovered archaeologically in this area that might provoke the imagination as having served as metal standards in exchange. The excavations and surveys carried out from 1983 to 1988 by Heather Lechtman and Craig Morris in the Pisco and

[18]Rostworowski comments that in their sea voyages north, Chincha traders surely used rafts made of reed as well as those of balsa wood logs (1970: 154), calling attention to the trip made in 1969 by Gene Savoy in a reed raft from Salaverry, on the north coast of Peru, to Panama (1970: 155, fn. 10). It can be done, but was it done? Oviedo makes the interesting observation that "the balsas (sic) they use in these parts instead of ships, from the river Chira toward the south, are made of reeds" (1945: 12: 122). The Chira river flows out of the highlands of what is today southern Ecuador and discharges into the sea on the far north coast of Peru. It cuts the present Ecuador-Peru border. When it comes to the question of where Chincha navigators obtained their balsa logs, Rostworowski suggests that the timber was acquired from "northern ports," in other words, the tropical coast of present-day Ecuador (1970: 155, fn. 11). That must have been the case. Sabella, who has worked recently in the fishing hamlet of San Pablo (Piura), on the far north coast of Peru, describes the "*balsillas*" used by the local fishermen: "These rafts are fashioned from a brace of five *balsa* logs transported from Guayaquil, Ecuador . . ." (Sabella 1974: 199).

[19]". . . sólo ellos en este Reyno trataban con moneda, porque entre ellos compraban y vendían con cobre lo que avían de comer y vestir, y tenían puesto lo [que] valía cada marco de cobre . . ." [" . . . only they [the Chincha merchants] in this kingdom transact with money, because amongst them they bought and sold with copper what they need for food and dress and had determined the value of each quantity of copper . . ."] (Rostworowski 1970: 171; translation by O. Holm).

"*Moneda*" might also be translated "coins."

Chincha valleys have revealed no such materials (Lechtman, personal communication, 1988). Nevertheless, as Hosler points out (1986, 1988c), it is telling that the axe-money complex was introduced to West Mexico, albeit by Manabi traders, at about the time that the Chincha maritime presence was felt in the north, and may perhaps have been encouraged by it. It is also quite possible that the Chincha merchants took their cue from Manabi and entered the copper alloy exchange system because of its special symbolic and transactional importance in the north. What is not clear is the form the metal took, whether it was used primarily in Chincha or enjoyed a much wider circulation. Any direct relation, if such exists, between the copper "*moneda*" of the Chincha *mercaderes* and the *hachas monedas* of the peoples of Ecuador and West Mexico is nowhere apparent. We should point out, moreover, that both Ecuadorian and West Mexican axe-monies are made of arsenic bronze. The alloy of copper and arsenic is a central and north Andean alloy and was barely used in the southern Andes (see González 1979 for exceptions), where copper and tin (tin bronze) was the alloy of choice from the Late Intermediate period onwards (Lechtman 1979, 1980). It is highly unlikely, therefore, that Chincha merchants were transporting arsenic bronze from the south, and in any case there was no need to do so as the northern supplies were abundant. West Mexican arsenic bronze was produced from local ores: it was not an imported item (Hosler 1986, 1988a, 1988b, 1988c). At the same time, we have thus far to discover any caches, hoards or other evidence of tin bronze on the north Peruvian coast or on coastal Ecuador that might serve as a marker of Chincha presence and traffic in that alloy. The Chincha copper "*moneda*" remains a puzzle.

Axe-money is a phenomenon closely related to the system of maritime exchanges taking place in the north Andean zone from the Late Intermediate/ Late Integration periods until the Spanish invasion. Certain features of the core complex may have been set in Lambayeque, but development of the practical and symbolic aspects of the objects was in the hands of seafaring coastal Ecuadorian peoples and their West Mexican trade partners. The extent to which Chincha as a Pacific coast maritime actor may have influenced the dissemination of axe-monies northward is still unclear. Given this picture, we find it difficult to entertain Shimada's suggestion, though "highly speculative" (1985a: 391), ". . . of an extensive prehispanic economic exchange network that may have linked coastal Ecuador and the northern North Coast, South Coast, and North Highlands of Peru" (Shimada 1985a: 391) during the late Middle Horizon, with Batan Grande at its hub, "not only in terms of geographical location but also production and distribution of a (if not the) key item of exchange" (Shimada 1985a: 391)—namely, axe-monies and copper-arsenic alloy. None of the evidence we have presented here supports that stance. It should also be noted that Lambayeque is not mentioned in the Chincha document—though Shimada claims it is (Shimada 1985a: 389; 1987a: 142)—which describes the Chincha economic scene during the last years of the Inka empire and which probably reflects the situation during the fourteenth and fifteenth centuries, which we take to be the apogee of Chincha economic and political sway. The coastal Andean exchange network *did* have considerable antiquity, but its origins lay in the warm equatorial waters farther north.

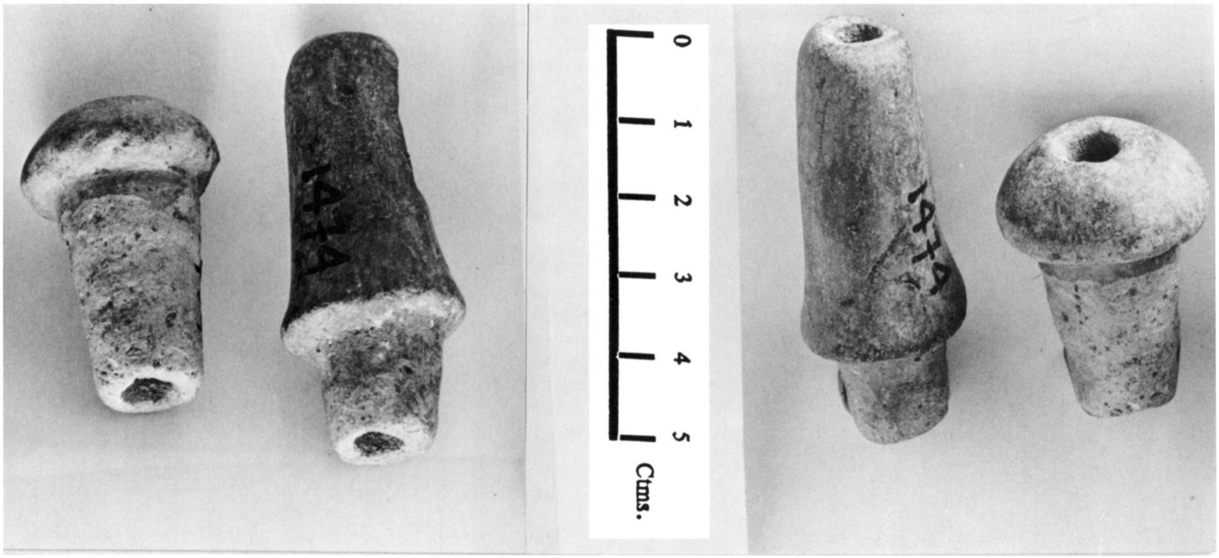


Fig. 46 Two ceramic blowpipe tips (*toberas*) are among a group of four such items excavated from the Cacique Guayas urn burial at the site of La Compañia, Los Rios Province, Ecuador. The bore diameter of the longer *tobera* measures 0.53 cm. Photograph by Carlos Mora. Collection: Museo Antropológico del Banco Central del Ecuador, Guayaquil, Ecuador.

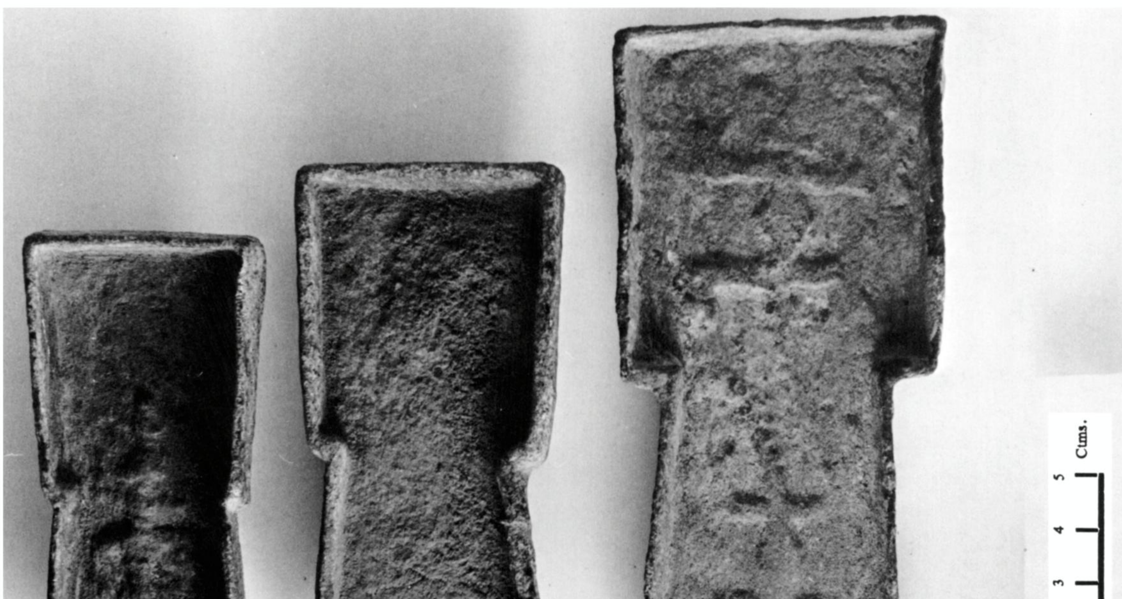


Fig. 47 Arsenic bronze "*tabletas*" excavated at the site of La Compañia, Los Rios Province, Ecuador. The use of these objects is unknown. Two bear relief figures in the form of a lizard, and are similar to others of the same general shape and decoration from the north coast of Peru. The middle example was analyzed and is made of an alloy of copper containing 1.59% arsenic. Photograph by Carlos Mora. Collection: Museo Antropológico del Banco Central del Ecuador, Guayaquil, Ecuador (GA 161.914.78; GA 162.914.78/MIT 3507; GA 160.914.78).

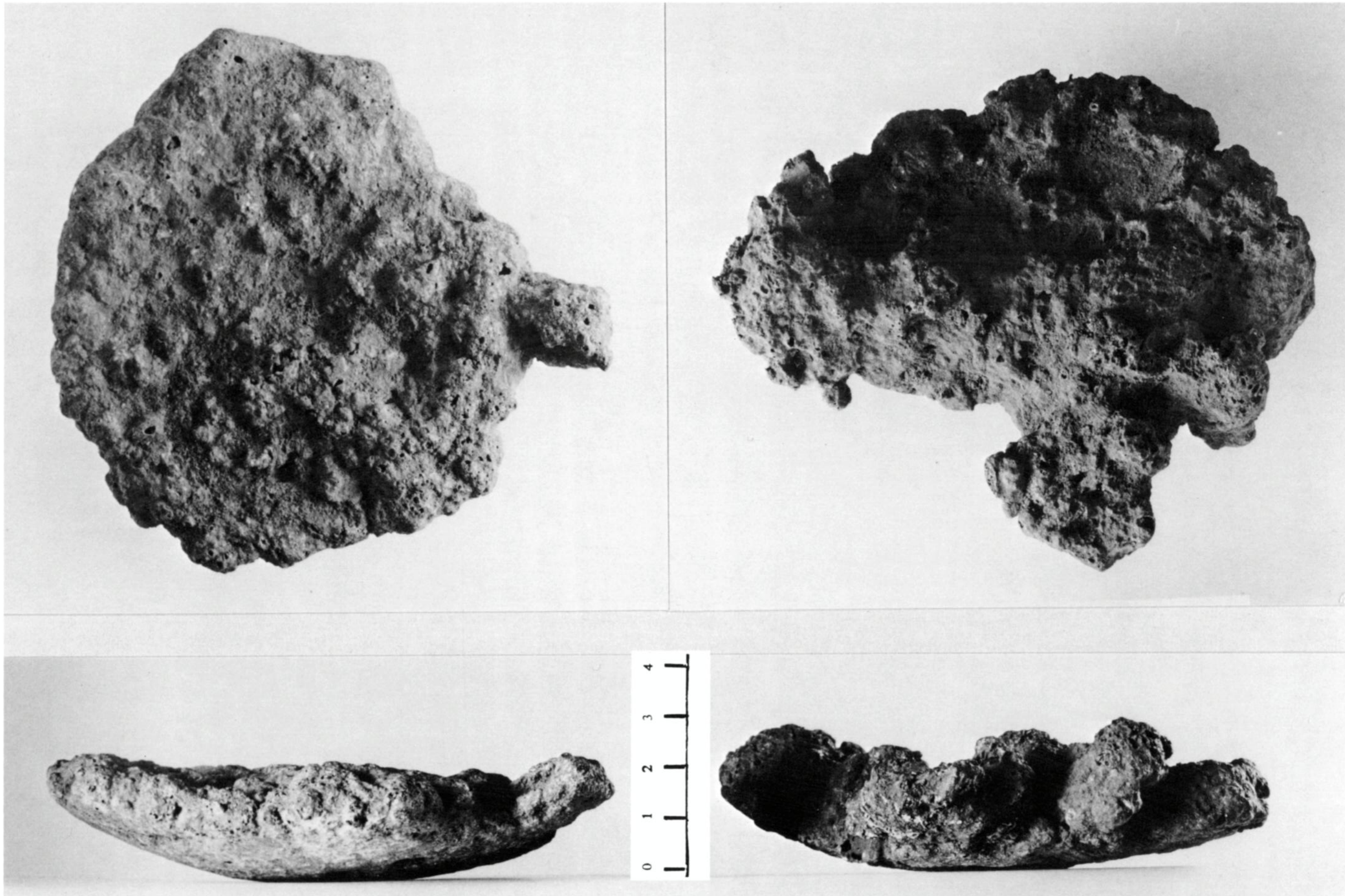


Fig. 48 Two plano-convex ingots excavated from the Cacique Guayas urn burial at the site of La Compañia, Los Rios Province, Ecuador. These appear to be crucible ingots. They are low arsenic, copper-arsenic alloys containing 0.3–0.4% arsenic, by weight. Above: view from top. Below: view from side. Photograph by Carlos Mora. Collection: Museo Antropológico del Banco Central del Ecuador, Guayaquil, Ecuador (GA 284.914.78 (L1)/MIT 3502; GA 284.914.78 (L2)/MIT 3503).

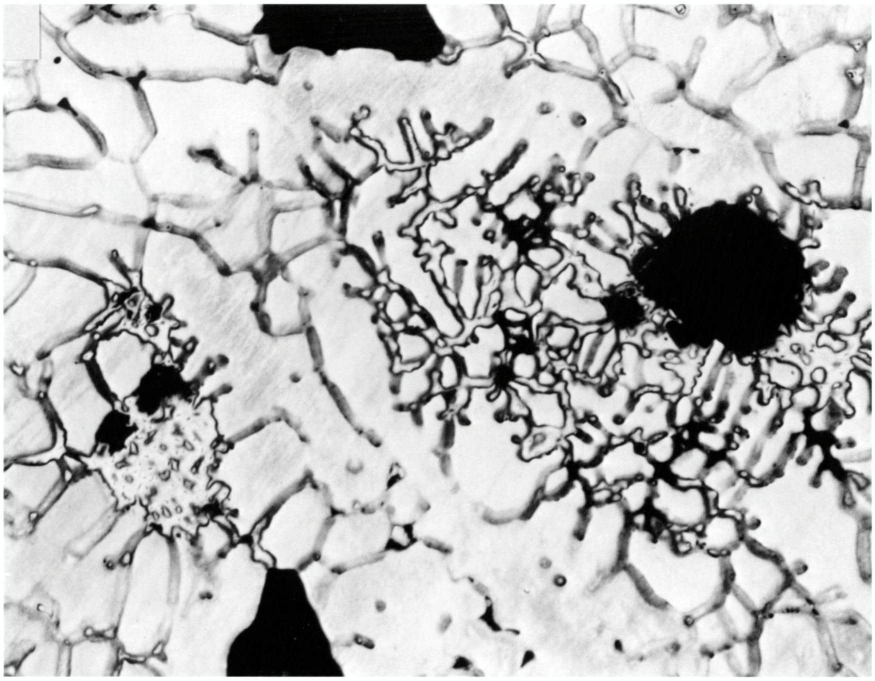


Fig. 49. Photomicrograph of a cross section of metal removed from the ingot at the right in Figure 48. The alloy is porous (large black areas) and highly segregated, the metal higher in arsenic forming a network in the interdendritic spaces. At the lower left a small zone of metal has concentrated enough arsenic to have precipitated tiny specs of a second phase (Cu_3As). Alloy: Cu, 0.30% As. Magnification: 50. Etchant: potassium dichromate.

RANGE OF ARSENIC CONCENTRATION IN MEXICAN AXE-MONIES

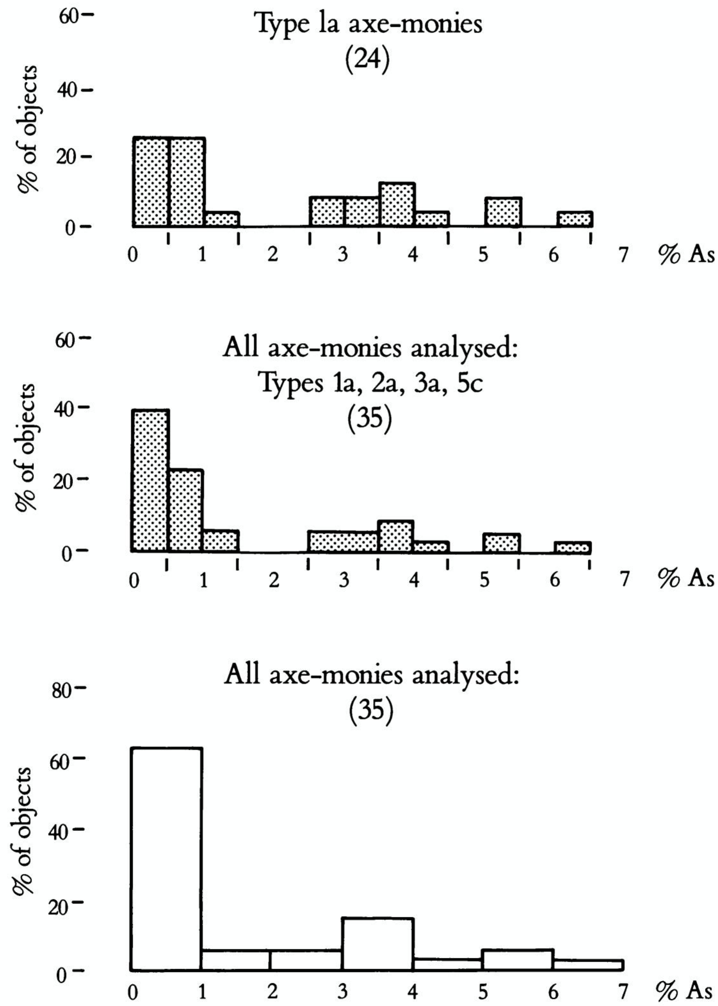
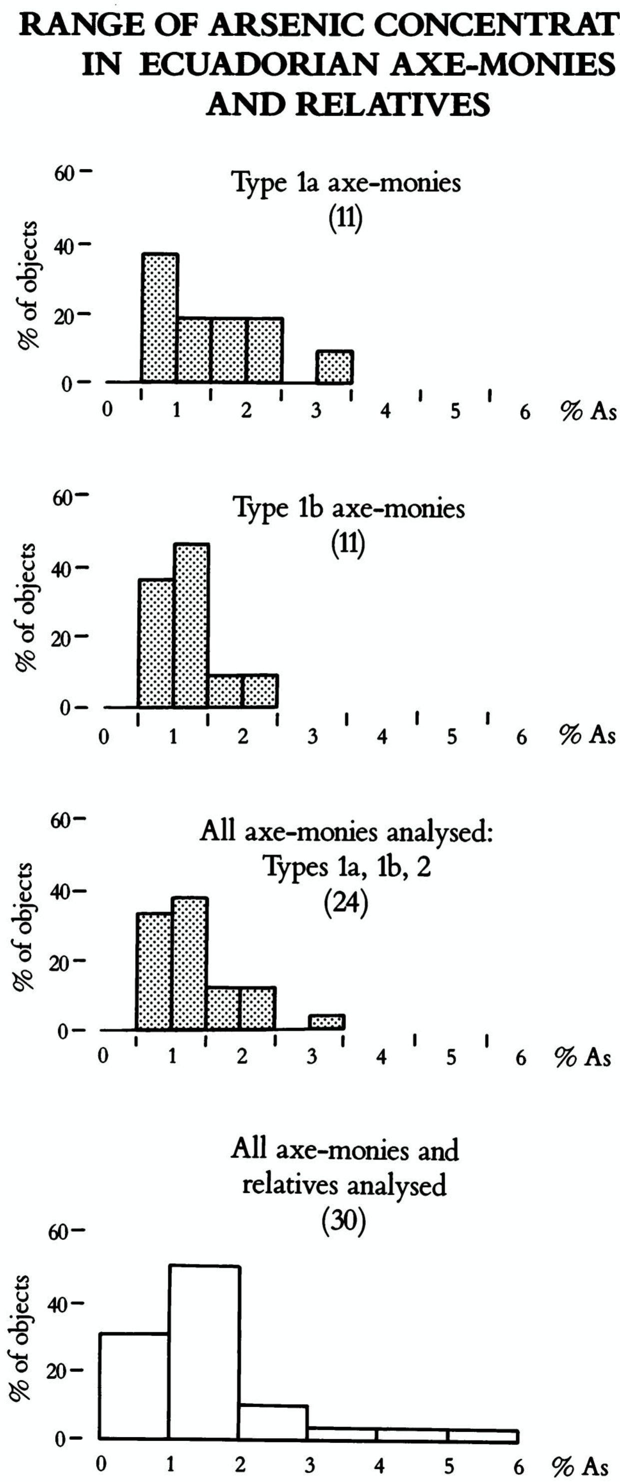


Fig. 50. Histograms showing the distribution of Mexican axe-monies as a function of the arsenic concentration in the metal of which they are made. A separate plot represents Type 1a axe-monies, from West Mexico.



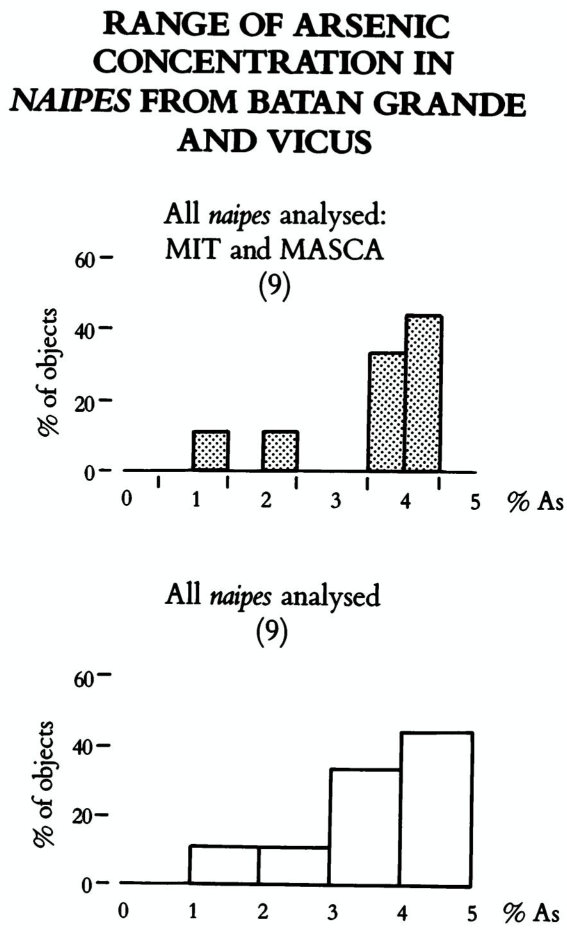


Fig. 51a Histograms showing the distribution of Ecuadorian axe-monies as a function of the arsenic concentration in the metal of which they are made. Types 1a and 1b axe-monies have been plotted individually, and the bottom histogram includes all Ecuadorian axe-monies and relatives analyzed and reported in Table 2.

Fig. 51b Histogram showing the distribution of *naipes* as a function of the arsenic concentration in the metal of which they are made. The data are from Table 2 and Shimada 1985: 387.

Acknowledgments

Over the years, many colleagues and students have contributed to the research reported here, and we wish to thank them for their help and participation. Dorothy Hosler thanks especially Otto Schöndube and Frederico Solórzano of the INAH at the Museo Regional de Guadalajara, Guadalajara, Jalisco, Mexico for their encouragement and access to the museum's collections. The authors collectively thank the personnel of the Centro Regional de Oaxaca, Oaxaca, Mexico; Hernán Crespo and Vicente Sierra of the Museo Arqueológico del Banco Central del Ecuador, Quito; Felipe Cruz of the Museo Antropológico del Banco Central del Ecuador, Guayaquil; Resfa Parducci of the Museo de Arte Prehistórico de la Casa de la Cultura, Guayaquil, Ecuador; Jorge Marcos of the Escuela Superior Politécnica del Litoral, Guayaquil, Ecuador; and the curatorial staff of the Department of Anthropology, American Museum of Natural History, New York for assistance during study of their collections.

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TABLE 1. CHRONOLOGIES FOR MEXICAN, NORTH ANDEAN, AND CENTRAL ANDEAN PREHISTORY

MEXICO

	Years	Relative Chronology			WEST MEXICO Historical Events / Cultures	OAXACA Historical Events / Cultures
	1521			Colonial	Spanish Empire	
	1500				Tarascan	Monte Albán V (Mixtec)
	1400	Postclassic	LATE	Aztec Period	Apatzingán (Michoacán)	
	1300				Culiacán (Sinaloa)	
	1200			Postclassic	Santa Cruz (Nayarit)	
	1100		EARLY	Toltec Period		Monte Albán IV
	1000				Aztatlán complex	
	900					
	800	Classic	LATE		Apatzingán (Michoacán); Cojumatlán (Jalisco)	Monte Albán IIIb
	700					
	600			Classic	El Arenal (Jalisco); Los Cocos; Amapa (Nayarit); Chametla (Sinaloa)	
	500		EARLY			Monte Albán IIIa
	400				Ameca (Jalisco); Ortices (Colima)	
	300					
	200	Preclassic	LATE			
A.D.	100				Chanchopa-Ortices	
	0				Tuxcacuesco Early Ixtlán	
B.C.	100			Preclassic		
	200				Shaft tomb complex (Colima, Nayarit, Jalisco)	Monte Albán II
	300		EARLY			
	400					Monte Albán I
	500				San Blas (Nayarit)	

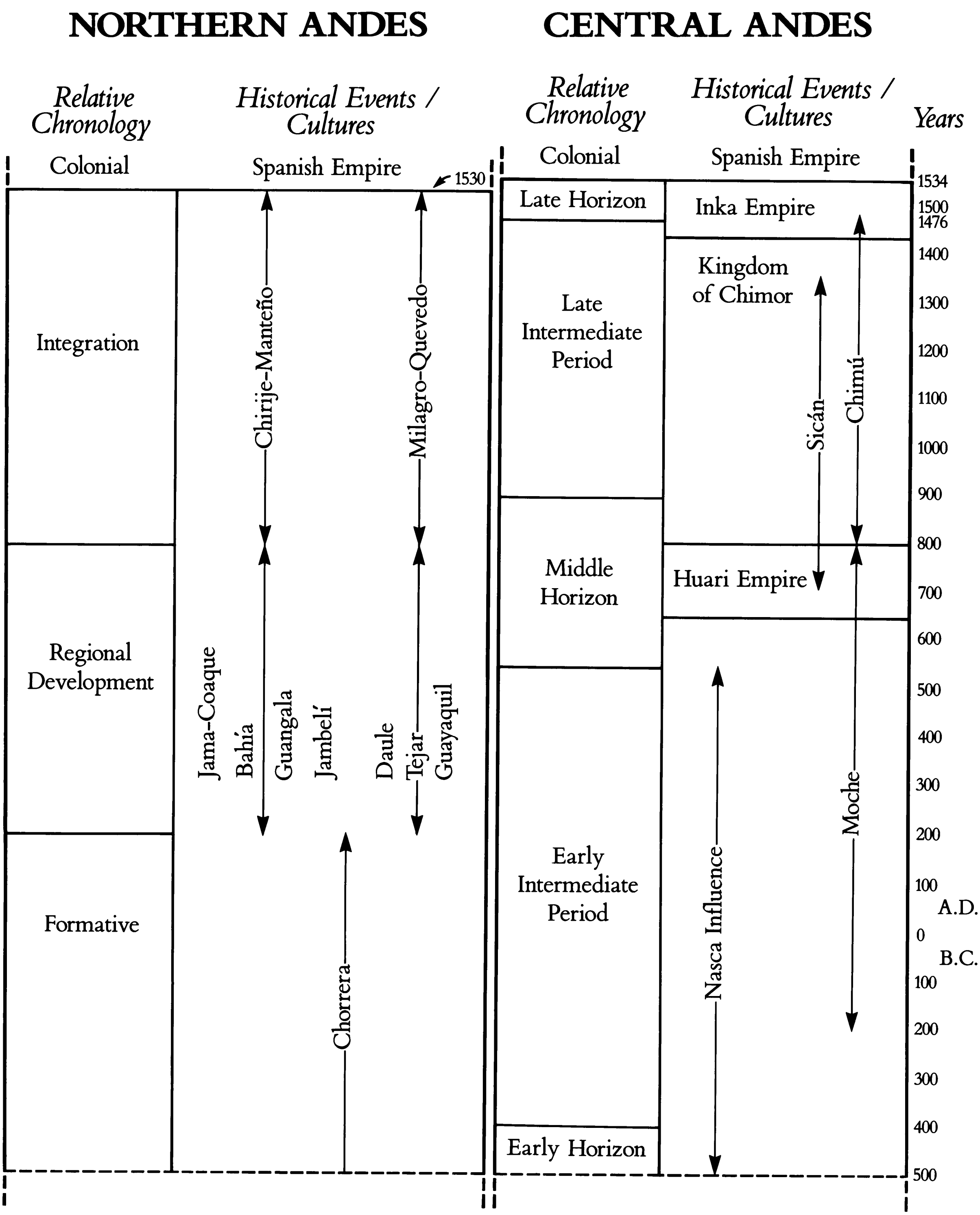
NORTHERN ANDES
CENTRAL ANDES
Relative Chronology
Historical Events / Cultures
Relative Chronology
Historical Events / Cultures
Years
Colonial
Spanish Empire
1530
Colonial
Spanish Empire
Integration
Regional Development
Formative
Chirije-Manteño
Milagro-Quevedo
Jama-Coaque
Bahía
Guangala
Jambelí
Daule
Tejar
Guayaquil
Chorrera
Late Horizon
Late Intermediate Period
Middle Horizon
Early Intermediate Period
Early Horizon
Inka Empire
Kingdom of Chimor
Sicán
Chimú
Huari Empire
Moche
Nasca Influence
1534
1500
1476
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
A.D.
0
B.C.
100
200
300
400
500

TABLE 2. CHEMICAL ANALYSES OF AXE-MONIES, RELATIVES, AND OTHER ASSOCIATED METAL ARTIFACTS

Collection	Catalog No./ Excavation No.: MIT No.	Type/ Feature	Provenience	Analytical mode	Chemical Analysis [% by weight] Ag	Al	As	Bi	Ca	Fe	In	Mg	Mn	Ni	Pb	Sb	Si	Sn	Zn
				MEXICO															
				AXE-MONIES															
MRG	F298: MIT 3467	1a	Oaxaca	ES;AA	0.01	?	0.81	0.04	?	?	—	v	—	0.01	0.01	0.10	m−	0.01	—
MRG	F299: MIT 3468	1a	Oaxaca	ES;AA	0.10	?	4.31	0.01	—	v	—	v	—	0.02	0.26	0.04	m	v−	—
MRG	F302	1a	Oaxaca	ES;NAA	0.23	v	3.38	—	—	v	0.3 PPM	v	—	v	v	0.008	m	?	—
MRG	F307: MIT 3471	1a	Oaxaca	ES;AA	0.28	v	3.80	0.04	—	?	—	m−	—	0.02	0.09	0.01	m	0.04	—
MRG	F308: MIT 3469	1a	Oaxaca	ES;AA	0.13	v	2.79	0.02	v	v	—	m−	?	0.02	0.02	0.01	m	—	—
MRG	F309: MIT 3470	1a	Oaxaca	ES;AA	0.001	v	0.60	0.004	—	v	—	v	—	?	v	0.055	m	v+	—
MRG	F420: MIT 3472	1a	Michoacán	ES;AA	0.30	v	1.21	0.04	—	v	—	v+	—	0.02	0.02	0.04	m	v	—
MRG	F427: MIT 3473	1a	Michoacán	ES;AA	0.01	v	0.53	0.04	?	v	—	v+	—	0.01	0.02	0.02	m	0.02	—
MRG	F434: MIT 3474	1a	Michoacán	ES;AA	—	—	0.07	0.03	—	v	—	v+	—	0.01	0.02	0.02	m	0.01	—
MRG	F439: MIT 3475	1a	Michoacán	ES;AA	0.003	?	0.70	0.003	—	v	—	v	—	0.01	v+	0.029	m−	v	—
MRG	F449	1a	Michoacán	ES;NAA	0.17	—	3.71	—	—	v	0.1PPM	v+	?	v	v	0.033	m	v	—
MRG	F454: MIT 3476	1a	Michoacán	ES;AA	0.01	?	0.25	0.08	?	?	—	v	—	0.01	0.04	0.06	m	v	—
MRG	F463	1a	Michoacán	ES;AA	0.46	?	6.35	—	?	v	—	v	?	0.05	m−	0.28	m	0.023	—
MRG	F469: MIT 3477	1a	Michoacán	ES;AA	0.02	v	0.87	0.04	?	v	—	m−	?	0.01	0.02	0.02	0.10	—	—
MRG	F471	1a	Michoacán	ES;NAA	0.22	—	3.95	m	v	v	1.2PPM	v+	?	v	v+	0.17	m	v+	—
MRG	F473: MIT 3478	1a	Michoacán	ES;AA	—	—	0.27	0.04	?	v	—	v+	?	0.03	0.02	0.01	m	—	—
MRG	F485	1a	Michoacán	ES	m−	v	v	v	v	v	—	m−	v	v	v	v	m	v	—
MRG	F486	1a	Michoacán	ES;AA	0.18	?	3.07	—	?	v−	—	v	—	0.09	—	0.23	m−	—	—
MRG	F487	1a	Michoacán	ES;AA	0.004	v	0.30	0.008	?	?	—	v	—	0.05	—	0.008	m−	0.045	—
MRG	F489	1a	Michoacán	ES;AA	0.05	v	0.81	v	m−	m−	—	m−	v	0.10	0.04	0.05	m−	—	—
MRG	F496	1a	Michoacán	ES;NAA	0.69	v	5.33	v	v	v	0.3PPM	m−	—	v	v+	0.14	m	—	0.003
MRG	F501	1a	Michoacán	ES;AA	0.04	?	—	—	v	?	—	v	—	0.03	—	0.43	v	0.027	—
MRG	F510	1a	Michoacán	ES;AA	—	m	0.05	—	v+	v	—	m−	?	0.13	—	0.09	m	0.03	—
DE/MIT	MIT 196	1a	Guerrero	ES;AA	0.28	?	5.39	0.03	?	v−	—	v	—	0.03	0.02	0.15	v−	?	—
DE/MIT	MIT 197	1a	Guerrero	ES;AA	0.11	v	2.82	?	v	v	—	v+	—	0.11	0.26	v	v+	0.06	—

Collection	Catalog No./ Excavation No.: MIT No.	Type/ Feature	Provenience	Analytical mode	Chemical Analysis [% by weight] Ag	Al	As	Bi	Ca	Fe	In	Mg	Mn	Ni	Pb	Sb	Si	Sn	Zn
MRG	F244	2a	Oaxaca	ES	v	v−	?	?	v	v	—	v	v−	v	v	?	m−	?	—
MRG	F245: MIT 3459	2a	Oaxaca	ES;AA	0.01	v−	0.19	0.02	v−	v	—	v	?	0.02	0.01	0.02	m−	—	—
MRG	F247: MIT 3460	2a	Oaxaca	ES;AA	—	v−	0.19	0.02	v	v	—	v	—	0.02	0.01	0.02	v+	—	—
MRG	F248	2a	Oaxaca	ES	m	v+	v	?	—	v	—	m−	—	?	v−	v	m	m−	—
MRG	F261: MIT 3461	2a	Oaxaca	ES;AA	0.12	v+	0.75	0.03	—	?	?	v+	—	0.02	0.03	0.13	m	—	—
MRG	F264	2a	Oaxaca	ES;AA	0.04	—	0.44	—	—	?	—	v+	—	—	—	0.04	v+	0.024	—
MRG	F276: MIT 3462	2a	Oaxaca	ES;AA	0.03	v	1.21	0.02	v	v−	—	v+	—	0.01	0.01	0.10	v	—	—
DE/MIT	MIT 548	2a	Oaxaca	ES;AA	0.02	?	0.07	0.02	?	?	—	v	?	0.02	0.01	0.02	m−	0.01	—
MRG	F316: MIT 3466	3a	Oaxaca	ES;AA	0.06	v−	0.18	0.05	v−	?	—	v	?	0.04	0.02	0.06	m−	—	—
MRG	F332: MIT 3464	3a	Oaxaca	ES;AA	0.06	v−	0.14	0.04	v	—	—	v	—	0.03	0.02	0.06	v+	—	—
MRG	F346: MIT 3463	3a	Oaxaca	ES;AA	0.05	v−	0.08	0.03	v	?	—	v	—	0.05	0.02	0.04	v+	—	—
MRG	F347: MIT 3465	3a	Oaxaca	ES:AA	0.04	—	0.02	0.03	?	v	—	v	v−	0.02	0.01	0.04	v+	—	—
PMC	28-21-20/ 10125: MIT 817	5c	Oaxaca	ES;AA	v	v	0.96	—	v−	v−	—	v−	?	v−	v−	v	v	?	—

ECUADOR

AXE-MONIES

Collection	Catalog No./ Excavation No.: MIT No.	Type/ Feature	Provenience	Analytical mode	Ag	Al	As	Bi	Ca	Fe	In	Mg	Mn	Ni	Pb	Sb	Si	Sn	Zn
MAG	MIT 3282	1a	Las Palmas	ES;AA	0.03	—	2.43	v+	—	—	—	?	—	0.14	0.36	?	v+	?	—
MAG	MIT 3310	1a	El Barro	ES;AA	0.02	v−	1.81	0.05	?	v−	—	v	?	0.02	0.09	0.13	v	—	—
MAG	MIT 3427	1a	Balao Chico	ES;AA	0.04	v−	0.71	0.06	?	?	—	v	?	0.04	0.38	0.01	v+	—	—
MAG	MIT 3428	1a	Balao Chico	ES;AA	0.04	v−	2.34	0.06	v−	?	—	v−	?	0.03	0.09	0.02	v+	—	—
MAG	MIT 3429	1a	Balao Chico	ES;AA	0.03	v−	1.82	0.06	v−	?	—	v−	?	0.03	0.36	0.02	v+	—	v
MAG	MIT 3431	1a	Jaramijó	ES;AA	0.02	?	3.14	0.05	?	?	—	v−	?	0.04	0.05	—	m	—	—
MAG	MIT 3432	1a	Jaramijó	ES;AA	0.05	?	1.31	0.04	?	v	—	v	?	0.02	0.18	—	v+	—	—
MAQ	416.125.72: MIT 3433	1a	Loma Cangrejitos	ES;AA	0.01	?	1.25	0.08	?	v	—	v	?	0.02	0.25	—	v+	—	—
MAQ	415.125.72: MIT 3434	1a	Loma Cangrejitos	ES;AA	0.02	?	0.96	0.02	?	?	—	v+	?	0.03	0.48	—	v+	—	—
MAQ	404.125.72: MIT 3435	1a	Loma Cangrejitos	ES;AA	0.02	?	0.90	0.05	?	?	—	v+	?	0.02	0.21	—	v+	0.02	—

TABLE 2. (cont.)

Collection	Catalog No./ Excavation No.: MIT No.	Type/ Feature	Provenience	Analytical mode	Chemical Analysis [% by weight] Ag	Al	As	Bi	Ca	Fe	In	Mg	Mn	Ni	Pb	Sb	Si	Sn	Zn
MAG	O-O-Ar-Ar-416-A/M409: MIT 3510	1a	Porvenir, Arenillas	EP			0.82												
MAG	MIT 3426	1b/packet	Balao Chico	EP															
	Leaf A						0.94												
	Leaf B						1.61												
	Leaf C						0.65												
MAG	MIT 3436	1b/packet	Churute	EP															
	Leaf A						1.35												
	Leaf B						1.48												
	Leaf C						0.71												
MAG	MIT 3453	1b/packet	Babahoyo	EP															
	Leaf A						1.16												
	Leaf B						1.21												
	Leaf C						2.45												
MAG	MIT 3454	1b	Babahoyo	EP			0.81												
MAG	MIT 3501	1b/ tiniest	Babahoyo	EP			1.13												
MAG	MIT 3283	2	El Barro	ES;AA	0.03	—	1.10	v+	?	—	—	v	—	0.19	0.39	?	v+	0.01	—
MAG	MIT 3430	2	Jaramijó	ES;AA	0.03	?	1.18	0.03	?	?	—	v−	?	0.03	0.03	0.01	m	—	—
FEATHERS																			
MAG	285.914.78 (P1): MIT 3442	Socket end	La Compañía	ES;AA	0.05	v	4.61	0.15	v−	v−	—	v+	—	0.03	—	0.01	m	—	—
MAG	285.914.78 (P2): MIT 3443	Socket end	La Compañía	ES;AA	0.04	v	5.20	0.05	v−	v−	—	v+	—	0.04	0.01	—	m	—	—
"HIDES"																			
MAG	120.127.76: MIT 3449	No grooves	El Carmen, Manglaralto	XRF			1.40												
MAG	260.914.78 (A): MIT 3508	No grooves	Manabí	ES;AA	0.04	?	0.77	0.003	m	v−	—	v	—	0.04	—	0.01	0.017	—	0.001
MAG	260.914.78 (B): MIT 3509	No grooves	Manabí	ES;AA	0.03	?	1.06	0.001	v	v	—	v	—	0.08	—	—	0.023	—	0.001
INSIGNIA																			
MAG	15.1169.79: MIT 3450	No grooves	Milagro	XRF			1.10												

Collection	Catalog No./ Excavation No.: MIT No.	Type/ Feature	Provenience	Analytical mode	Chemical Analysis [% by weight] Ag	Al	As	Bi	Ca	Fe	In	Mg	Mn	Ni	Pb	Sb	Si	Sn	Zn
							AXES												
MAG	228.2690.84: MIT 3444	Rectangular hole	N. Manabí	ES;AA	0.04	v+	1.06	0.07	v−	v−	—	v+	?	0.02	0.38	0.01	m	—	—
MAG	228.2690.84: MIT 3445	Round hole	N. Manabí	ES;AA	0.04	?	3.75	0.03	v−	v−	—	v	?	0.03	0.02	0.03	m	—	—
MAG	84.2008.81: MIT 3446	Round hole	N. Manabí	ES;AA	0.04	—	3.77	0.03	?	v	—	v	v	0.03	0.02	0.05	v+	—	—
MAG	61.2008.81: MIT 3447	Round hole	N. Manabí	ES;AA	0.04	—	3.81	0.03	?	?	—	v	?	0.05	0.01	0.02	v+	0.01	—
MAG	1.77.76: MIT 3481	Giant	Tenguel	ES;AA	0.04	—	2.36	0.01	v	v	—	v	?	0.03	0.02	0.03	?	—	—
MAP	1.C.C.N.G.: MIT 3482	Giant		ES;AA	0.03	—	1.53	0.06	v	v+	—	v	v	0.02	0.09	0.03	v+	—	—
MAP	2.C.C.N.G.: MIT 3483	Giant		ES;AA	0.03	—	1.38	0.11	v+	m−	—	v	m−	0.02	0.21	0.02	v+	—	—
							INGOTS												
MAG	284.914.78 (L1): MIT 3502	Plano-convex	La Compañía	ES;AA	0.03	?	0.36	0.006	v+	?	—	v	—	0.05	0.02	0.003	0.029	—	0.001
MAG	284.914.78 (L2): MIT 3503	Plano-convex	La Compañía	ES;AA	0.04	?	0.30	0.008	v	?	—	v	—	0.05	0.02	0.01	0.021	—	0.001
MAG	8.1.88 (L3): MIT 3504	Plano-convex	Manabí	ES;AA	0.16	?	0.33	0.017	v+	?	—	v	—	0.02	0.73	0.004	0.027	—	0.002
MAG	8.1.88 (L4): MIT 3505	Plano-convex	Manabí	ES;AA	0.16	?	0.50	0.031	?	?	—	v	—	0.02	0.48	—	0.028	—	0.002
MAG	284.914.78 (L5): MIT 3506	Metal pour	La Compañía	ES;AA	0.09	?	0.37	0.003	m	v−	—	v	—	0.02	0.16	0.02	0.022	—	0.001
							OTHER												
MAG	162.914.78 (L1): MIT 3507	Tablet	La Compañía	ES;AA	0.07	v	1.59	0.003	m	v−	—	—	—	0.03	0.37	0.003	0.028	—	0.001
							PERU												
							NAIPES												
HR/MIT	MIT 3412	Flat	Vicús	ES;AA	0.02	v−	3.57	0.07	?	?	—	v−	?	0.01	0.05	—	v+	—	—
MAG	MIT 3437	Flat	Batán Grande	ES;AA	0.04	?	4.05	0.03	?	v	—	v+	?	0.03	0.01	0.01	v+	—	—
MAG	MIT 3438	Flat	Batán Grande	ES;AA	0.17	v	3.92	0.03	?	v	—	v+	?	0.01	—	—	m	—	—

TABLE 2. *(cont.)*

Collection	Catalog No./ Excavation No.: MIT No.	Type/ Feature	Provenience	Analytical mode	Chemical Analysis [% by weight] Ag	Al	As	Bi	Ca	Fe	In	Mg	Mn	Ni	Pb	Sb	Si	Sn	Zn
MAG	MIT 3439	Flat	Batán Grande	ES;AA	0.03	—	1.15	0.08	?	v	—	v+	?	0.01	0.64	0.01	m	0.01	v
MAG	MIT 3440	Flat	Batán Grande	ES;AA	0.08	—	4.37	0.09	?	?	—	v+	—	0.04	—	0.01	m	—	—
							FEATHERS												
HR/MIT	MIT 3490	Spatulate end	"Batanes"*	ES;AA	0.01	v−	1.98	0.009	?	v	—	v−	—	0.01	0.04	0.02	v	—	0.001
AMNH	41.1/436: MIT 3492	Spatulate end	Lambayeque One	XRF			2.55	(value refers to As in corrosion product)											

*See above, note 8.

KEY

AMNH	American Museum of Natural History, New York, New York	AA	Atomic absorption spectrophotometry
DE/MIT	Gift of Dudley T. Easby, Jr. to MIT Laboratory for Research on Archaeological Materials	EP	Electron probe microanalysis
HR/MIT	Gift of Henry Reichlen to MIT Laboratory for Research on Archaeological Materials	ES	Optical emission spectrography (qualitative analysis)
MAG	Museo Antropológico del Banco Central, Guayaquil, Ecuador	NAA	Neutron activation analysis
MAP	Museo de Arte Prehistórico, Casa de la Cultura, Guayaquil, Ecuador	XRF	X-ray fluorescence (surface analysis)
MAQ	Museo Arqueológico del Banco Central, Quito, Ecuador	—	Element not detected
MRG	Museo Regional de Guadalajara, Guadalajara, Jalisco, Mexico	m	Minor element
PMC	Peabody Museum of Archaeology and Ethnology, Cambridge, Mass.	v	Barely visible
		?	Presence questionable
		PPM	Parts per million

TABLE 3. DIMENSIONS AND WEIGHTS OF MEXICAN AXE-MONIES

Type	*Provenience* (collection)	*No. objects examined*	*Length* range [cm]	*Length* mean [cm]	*Weight* range [g]	*Weight* mean [g]
1a	West Mexico (MRG)	51	12.2–17.2	15.0	3.1–8.6	5.7
1a	Oaxaca (MRG)	14	17.6–20.5	19.6	9.2–19.8	14.9
2a	Oaxaca (MRG)	45	11.2–15.9	14.4	43.8–75.6	54.8
2a	Oaxaca (OTH)	27	11.7–14.9	13.1	46.0–64.0	55.3
2a	Oaxaca (all collections)	72	11.2–15.9	13.8	43.8–75.6	55.1
2b	Oaxaca* (OTH)	88	9.4–14.2	10.9	30.8–63.4	45.5
3a	Oacaxa (MRG)	37	13.1–14.9	14.0	42.4–68.9	52.9
4b	Oaxaca (MRG)	10	2.3–4.7	3.9	2.1–4.2	3.0
5a	Oaxaca (OTH)	99	8.0–13.9	9.7	5.2–17.2	10.4

KEY
MRG Museo Regional de Guadalajara
OTH Other collections: Frissel Museum, Mitla, Oaxaca; storage facility, Centro Regional de Oaxaca
*See above, note 11.

TABLE 4. DIMENSIONS AND WEIGHTS OF MEXICAN AXES

Provenience	*No. objects examined*	*Length* range [cm]	*Length* mean [cm]	*Weight* range [g]	*Weight* mean [g]
West Mexico (MRG)	35	6.4–16.0	11.2	29–600	204
Oaxaca (OTH)	25	6.0–17.0	11.7		
	17 of 25			12–2000	391

KEY
MRG Museo Regional de Guadalajara
OTH Other collections: Frissel Muesum, Mitla, Oaxaca.

Bibliography

Alva, Walter L.
1985 Una tumba con máscara funeraria de la costa norte del Perú. *AVA-Beiträge* 7: 411–421.

Antze, Gustav
1930 *Trabajos en metal en el norte del Perú.* Universidad Nacional Mayor de San Marcos, Lima.

Atienza, Lope de
1931 [1574?] Compendio historial del estado de los indios del Perú. In *La religión del imperio de los Incas,* Apéndices, vol. 1 (Jacinto Jijón y Caamaño, ed.). Escuela Tipográfica Salesiana, Quito.

Barrett, Elinore M.
1981 The King's Copper Mine, Inguarán in New Spain. *The Americas* 38(1): 1–29. Publication of the Academy of American Franciscan History.

Bennett, Wendell C.
1939 *Archaeology of the North Coast of Peru.* Anthropological Papers of the American Museum of Natural History, 37(1). New York.

Bergsøe, Paul
1937 The Metallurgy and Technology of Gold and Platinum among the Pre-Columbian Indians. *Ingeniørvidenskabelige Skrifter* A44: 1–45.

Bohannan, Paul
1955 Some Principles of Exchange and Investment among the Tiv. *American Anthropologist* 57: 60–70.
1959 The Impact of Money on an African Subsistence Economy. *Journal of Economic History* 19: 491–503.

Bohannan, Paul, and George Dalton
1962 Introduction. In *Markets in Africa* (Paul Bohannan and George Dalton, eds.): 1–26. Northwestern University Press, Evanston.

Bray, Warwick
1985 Ancient American Metallurgy. In *The Art of Precolumbian Gold. The Jan Mitchell Collection* (Elizabeth P. Benson, ed.): 76–84. The Metropolitan Museum of Art, New York.

Bushnell, G. H. S.
1951 *The Archaeology of the Santa Elena Peninsula in South-West Ecuador.* Cambridge University Press, Cambridge.

Cabos Y., Roger
1982 Estudios microscopicos, roentgenográficos y mediante microsonda de las asociaciones mineralógicas en el distrito minero Hualgayoc, Cajamarca—Peru. *Boletín de la Sociedad Geológica del Perú* 69: 1–17.

Caso, Alfonso
1963 Representaciones de hongos en los códices. *Estudios de Cultura Náhuatl* 4: 27–36.
1965 Lapidary Work, Goldwork, and Copperwork from Oaxaca. In *Archaeology of Southern Mesoamerica* (Gordon R. Willey, ed.): 896–930. Handbook of Middle American Indians, 3.2 (Robert Wauchope, gen. ed.). University of Texas Press, Austin.

Castillo G., Gastón, Marcos Biskupović M., and Gabriel Cobo C.
1986 Un cementerio costero del complejo cultural Las Animas. *Actas del 9° Congreso Nacional de Arqueología* (1982): 194–239. Dirección General de Bibliotecas, Archivos y Museos, La Serena.

Clark, James Cooper (ed. and trans.)
1938 *Codex Mendoza.* 3 vols. Waterlow & Sons, Ltd., London.

Conklin, William J
1982 The Information System of Middle Horizon Quipus. *Annals of the New York Academy of Sciences* 385: 261–281.

Cordy-Collins, Alana
n.d. Fonga Sigde, Shell Purveyor to the Chimu Kings. In *The Northern Dynasties: Kingship and Statecraft in Chimor* (Alana Cordy-Collins and Michael E. Moseley, eds.). Dumbarton Oaks, Washington, D.C. (in press).

Cornely, F. L.
1956 *Cultura diaguita chilena, y Cultura de El Molle.* Editorial del Pacífico S.A., Santiago de Chile.

Curtin, Philip D.
1975 *Economic Change in Precolonial Africa: Senegambia in the Era of the Slave Trade.* University of Wisconsin Press, Madison.

Dalton, George
1965 Primitive Money. *American Anthropologist* 67: 44–65.

1977 Aboriginal Economies in Stateless Societies. In *Exchange Systems in Prehistory* (Timothy Earle and Jonathon Ericson, eds.): 191–212. Academic Press, New York.

DISSELHOFF, H. D.
1958 Cajamarca—Keramik von der Pampa von San José de Moro (Prov. Pacasmayo). *Baessler-Archiv* N.F. 6: 181–194.

EASBY, JR., DUDLEY T., EARLE R. CALEY, and KHOSROW MOAZED
1967 Axe-Money: Facts and Speculation. *Revista Mexicana de Estudios Antropológicos* 21: 107–136.

EDWARDS, CLINTON R.
1965 *Aboriginal Watercraft on the Pacific Coast of South America.* University of California Press, Berkeley.

EINZIG, PAUL
1966 [1949] *Primitive Money in Its Ethnological, Historical and Economic Aspects.* 2nd ed. Pergamon Press, Oxford.

EPSTEIN, STEPHEN M., and IZUMI SHIMADA
1983 Metalurgia de Sicán. Una reconstrucción de la producción de la aleación de cobre en el Cerro de los Cementerios, Perú. *AVA-Beiträge* 5: 379–430.

ERICKSEN, GEORGE E., MARIANO IBERICO, and ULRICH PETERSEN B.
1956 *Geología del distrito minero de Hualgayoc, Departamento de Cajamarca.* Boletín 16. Ministerio de Fomento y Obras Públicas, Instituto Nacional de Investigación y Fomento Mineros, Lima.

ESCALERA U., ANDRÉS, and M. ANGELES BARRIUSO P.
1978 Estudio científico de los objetos de metal de Ingapirca (Ecuador). *Revista Española de Antropología Americana* 8: 19–45.

ESTRADA, EMILIO
1954 *Ensayo preliminar sobre arqueología del Milagro.* Archivo Histórico del Guayas, Ecuador.
1955 Balsa and Dugout Navigation in Ecuador. *The American Neptune* 15: 142–149.
1957 *Ultimas civilizaciones pre-históricas de la cuenca del Río Guayas.* Publicación del Museo Víctor Emilio Estrada 2. Guayaquil.

ESTRADA, JENNY (ED.)
1988 *La balsa en la historia de la navegación ecuatoriana.* Instituto de Historia Marítima, Guayaquil.

ESTRELLA, EDUARDO
1988 *El pan de América.* Editorial Abya-Yala, Quito.

EVANS, CLIFFORD, and BETTY MEGGERS
1961 Cronología relativa y absoluta en la costa del Ecuador. *Cuadernos de Historia y Arqueología* 10(27): 147–152. Casa de la Cultura, Guayaquil.

FIRTH, RAYMOND
1983 Magnitudes and Values in Kula Exchange. In *The Kula* (Jerry W. Leach and Edmund Leach, eds.): 89–102. Cambridge University Press, Cambridge.

FURST, JILL LESLIE
1978 *Codex Vindobonensis Mexicanus I: A Commentary.* Institute for Mesoamerican Studies Publication 4. State University of New York, Albany.

GONZÁLEZ, ALBERTO REX
1979 Pre-Columbian Metallurgy of Northwest Argentina: Historical Development and Cultural Process. In *Pre-Columbian Metallurgy of South America* (Elizabeth P. Benson, ed.): 133–202. Dumbarton Oaks, Washington, D.C.

GOOSSENS, PIERRE J.
1972a Metallogeny in the Ecuadorian Andes. *Economic Geology* 67: 458–468.
1972b *Los yacimientos e indicios de los minerales metálicos y no metálicos de la República del Ecuador.* Universidad de Guayaquil, Guayaquil.

GREGORY, CHRIS
1983 Kula Gift Exchange and Capitalist Commodity Exchange: A Comparison. In *The Kula* (Jerry W. Leach and Edmund Leach, eds.): 103–117. Cambridge University Press, Cambridge.

GRIERSON, PHILIP
1978 The Origins of Money. *Research in Economic Anthropology* 8: 1–35.

GUYER, JANE I.
1986 Indigenous Currencies and the History of Marriage Payments. *Cahiers d'Etudes Africaines* 104 (xxvi–4): 577–610.

HERBERT, EUGENIA W.
1984 *Red Gold of Africa.* University of Wisconsin Press, Madison.

HEYERDAHL, THOR
1955 The Balsa Raft in Aboriginal Navigation off Peru and Ecuador. *Southwestern Journal of Anthropology* 11: 251–264.

HOLM, OLAF
1953 El tatuaje entre los aborígenes prepizzarianos de la costa ecuatoriana. *Cuadernos de Historia y Arqueología* 3 (7–8): 56–92.
1966/67 Money Axes from Ecuador. *Folk* 8–9: 136–143.
1978 Hachas monedas del Ecuador. In *Actas y Trabajos del 3° Congreso Peruano, El Hombre y la Cultura Andina* (Ramiro Matos M., ed.) 1: 347–361. Lima.
1980 Monedas primitivas del Ecuador prehistórico. *Cuadernos Prehispánicos* 8(8): 53–67.
n.d. Torteras vs. toberas. *Cultura.* Banco Central del Ecuador, Quito (in press).

HOSLER, DOROTHY
1986 *The Origins, Technology and Social Construction of Ancient West Mexican Metallurgy.* Ph.D. dissertation, University of California, Santa Barbara. University Microfilms, Ann Arbor.
1988a The Metallurgy of Ancient West Mexico. In *The Beginning of the Use of Metals and Alloys* (Robert Maddin, ed.): 328–343. MIT Press, Cambridge, Mass.
1988b Ancient West Mexican Metallurgy: A Technological Chronology. *Journal of Field Archaeology* 15: 191–217.

1988c Ancient West Mexican Metallurgy: South and Central American Origins and West Mexican Transformations. *American Anthropologist* 90: 832–855.

n.d. Style in Materials: The Metallurgy of Ancient West Mexico. Ms. on file, 1987, Center for Materials Research in Archaeology and Ethnology, Massachusetts Institute of Technology, Cambridge, Mass.

ISHIDA, EIICHIRO (ED.)

1960 *Andes: Report of the University of Tokyo Scientific Expedition to the Andes in 1958.* Bijutsu-shuppansha, Tokyo.

JEVONS, W. STANLEY

1875 *Money and the Mechanism of Exchange.* D. Appleton & Co., New York.

JIJÓN Y CAAMAÑO, JACINTO DE

1940–1947 *El Ecuador interandino y occidental antes de la conquista castellana.* 4 vols. Editorial Ecuatoriana, Quito.

LEACH, JERRY W., and EDMUND LEACH (EDS.)

1983 *The Kula: New Perspectives on Massim Exchange.* Cambridge University Press, Cambridge.

LECHTMAN, HEATHER

1973 The Gilding of Metals in Pre-Columbian Peru. In *Application of Science in Examination of Works of Art* (William J. Young, ed.): 38–52. Museum of Fine Arts, Boston.

1976 A Metallurgical Site Survey in the Peruvian Andes. *Journal of Field Archaeology* 3: 1–42.

1979 Issues in Andean Metallurgy. In *Pre-Columbian Metallurgy of South America* (Elizabeth P. Benson, ed.): 1–40. Dumbarton Oaks, Washington, D.C.

1980 The Central Andes: Metallurgy Without Iron. In *The Coming of the Age of Iron* (Theodore A. Wertime and James D. Muhly, eds.): 269–334. Yale University Press, New Haven.

1981 Copper-arsenic Bronzes from the North Coast of Peru. In *Annals of the New York Academy of Sciences* 376 (Anne-Marie Cantwell, James B. Griffin, and Nan A. Rothschild, eds.): 77–121. The New York Academy of Sciences, New York.

1988 Traditions and Styles in Central Andean Metalworking. In *The Beginning of the Use of Metals and Alloys* (Robert Maddin, ed.): 344–378. MIT Press, Cambridge, Mass.

MACFARLANE, ANDREW W., and ULRICH PETERSEN

n.d. Lead Isotopes of the Hualgayoc Area, Northern Peru. *Economic Geology* (in press).

MARCET, PABLO, ULRICH PETERSEN, and ANDREW W. MACFARLANE

1987 Lead Isotopic Compositions of Andean Ores—Implications of Generic Variabilities. *Abstracts of the Geological Society of America* 19 (7): 760.

MARCOS, JORGE G.

1978 Cruising to Acapulco and Back with the Thorny Oyster Set: Model for a Lineal Exchange System. *Journal of the Steward Anthropological Society* 9 (1–2): 99–132.

1981 Informe sobre el área ceremonial del complejo Manteño Huancavilca de la Loma de los Cangrejitos, Valle de Chanduy, Ecuador. *El Arquitecto* 1(5): 54–63.

MARCOS, JORGE, and PRESLEY NORTON

1981 Interpretación sobre la arqueología de la Isla de La Plata. *Miscelania Antropológica Ecuatoriana. Boletín de los Museos del Banco Central del Ecuador* 1: 136–154.

MAYER, EUGEN F.

1982a Metallgeld und Metallbesitz in Altamerika. *AVA-Beiträge* 4: 287–293.

1982b *Chanchán: Vorspanische Stadt in Nordperu.* Verlag C. H. Beck, Munich.

1986 *Armas y herramientas de metal prehispánicas en Argentina y Chile.* Materialen zur allgemeinen und vergleichenden Archäologie 38. Verlag C. H. Beck, Munich.

MEDINA, JOSÉ TORIBIO

1912 Monedas usadas por los indios de América al tiempo del descubrimiento. *Actas del 17° Congreso Internacional de Americanistas* (1910): 556–567. Buenos Aires.

MEGGERS, BETTY J., CLIFFORD EVANS, and EMILIO ESTRADA

n.d. Field notes: Excavation at La Compañía, Los Ríos Province, Ecuador, 1961. On file at the Museo Antropológico del Banco Central del Ecuador, Guayaquil.

MEJÍA XESSPE, TORIBIO

1960 Algunos nuevos elementos de la civilización Recuay-Pasto en el extremo norte del litoral peruano. In *Antiguo Perú: Espacio y Tiempo* (Ramiro Matos M., ed.): 205–217. Librería-Editorial Juan Mejía Baca, Lima.

MELGAREJO VIVANCO, JOSÉ LUIS

1980 *El Codice Vindobonensis.* Instituto de Antropología, Universidad Veracruzana, Xalapa, Mexico.

MELITZ, JACQUES

1974 *Primitive and Modern Money.* Addison-Wesley, Reading.

MINATO, HIDEO

1960 Chemical Analysis of Copper and Bronze Wares. In *Andes: The Report of the University of Tokyo Scientific Expedition to the Andes in 1958* (Eiichiro Ishida, ed.): 516–518. Bijutsu-shuppansha, Tokyo.

MORSE, BIRGIT F., and ROBERT B. GORDON

1986 Metallographic Examination of Pre-Columbian Mexican Copper and Silver Artifacts from Mitla, Oaxaca (Mexico). *Archeomaterials* 1: 57–67.

MOTOLINIA, FRAY TORIBIO DE

1903 *Memoriales.* Documentos históricos de Méjico T. 1. Luis García Pimentel, Mexico.

MURRA, JOHN V.

1975 El tráfico de *mullu* en la costa del Pacífico. In *Formaciones económicas y políticas del mundo*

andino (John V. Murra): 255–267. Instituto de Estudios Peruanos, Lima.
MUSEO CHILENO DE ARTE PRECOLOMBINO
1986 *Diaguitas: Pueblos del Norte Verde.* Museo Chileno de Arte Precolombino, Santiago de Chile.
NETHERLY, PATRICIA JOAN
1977 *Local Level Lords on the North Coast of Peru.* Ph.D. dissertation, Cornell University. University Microfilms, Ann Arbor.
NORTON, PRESLEY
1987 El señorío de Salangone y la liga de mercaderes. *Miscelanea Antropológica Ecuatoriana. Boletín de los Museos del Banco Central del Ecuador* 6: 131–143.
OBEREM, UDO, and ROSWITH HARTMANN
1982 Zur Seefahrt in den Hochkulturen Alt-Amerikas. *AVA-Kolloquien* 2: 121–157.
ORTIZ RUBIO, PASCUAL
1920 *Historia de Michoacán.* Morelia, Michoacán, Mexico.
OVIEDO Y VALDÉS, GONZALO FERNÁNDEZ DE
1945 [1535/48] *Historia general y natural de las Indias.* 13 vols. Editorial Guaranía, Asunción del Paraguay.
PALADINES P., AUGUSTIN, and HÉCTOR SANMARTÍN D.
1980 *Mapa metalogénico del Ecuador.* Ministerio de Recursos Naturales y Energéticos, Dirección General de Geología y Minas, Ecuador.
PASO Y TRONCOSO, FRANCISCO DEL (ED.)
1905–1906 *Papeles de Nueva España.* 2nd ser., 7 vols. Madrid.
PAULSEN, ALLISON C.
1974 The Thorny Oyster and the Voice of God: *Spondylus* and *Strombus* in Andean Prehistory. *American Antiquity* 39: 597–607.
1977 Patterns of Maritime Trade between South Coastal Ecuador and Western Mesoamerica, 1500 B.C.–A.D. 600. In *The Sea in the Pre-Columbian World* (Elizabeth P. Benson, ed.): 141–160. Dumbarton Oaks, Washington, D.C.
PEASE G.Y., FRANKLIN
1978 *Del Tawantinsuyu a la historia del Perú.* Instituto de Estudios Peruanos, Lima.
PEDERSEN, ASBJÖRN
1976 El ajuar funerario de la Tumba de la Huaca Menor de Batán Grande, Lambayeque, Perú. *Actas del 41 Congreso Internacional de Americanistas* 2:60–73. Mexico City.
PENDERGAST, DAVID M.
1962 Metal Artifacts in Prehispanic Mesoamerica. *American Antiquity* 27: 520–545.
PETERSEN, ULRICH
1965 Regional Geology and Major Ore Deposits of Central Peru. *Economic Geology* 60: 407–476.
1970 Metallogenic Provinces in South America. *Geologischen Rundschau* 59: 834–897.
1972 Geochemical and Tectonic Implications of South American Metallogenic Provinces. *Annals of the New York Academy of Sciences* 196: 1–38.
POLANYI, KARL
1968 [1957] The Semantics of Money-Uses. In *Primitive, Archaic, and Modern Economies: Essays of Karl Polanyi* (George Dalton, ed.): 175–203. Beacon Press, Boston.
PONZONI S., EDGARDO (ED.)
1969 *Mapa metalogenético del Perú.* Sociedad Nacional de Minería y Petroleo, Lima.
PRÜMERS, HEIKO
n.d. Zum Problem des "Axtgeldes" im alten Peru. Ms. on file, 1988, Seminar für Völkerkunde, University of Bonn, Bonn.
RENCORET, FR. BENJAMIN
1875 *Apuntes que deben acompañar a la colección arqueológica americana que el R.P. Visitador Apostólico, Fr. Benjamin Rencoret, manda a la Exposición Internacional de Chile en 1875.* Imprenta Nacional, Quito.
ROSTWOROWSKI DE DIEZ CANSECO, MARÍA
1970 Mercaderes del Valle de Chincha en la época prehispánica. *Revista Española de Antropología Americana* 5: 135–178.
1988 *Historia del Tahuantinsuyu.* Instituto de Estudios Peruanos, Lima.
SABELLA, JAMES C.
1974 *The Fishermen of Caleta San Pablo.* Ph.D. dissertation, Cornell University. University Microfilms, Ann Arbor.
SAHAGÚN, FRAY BERNARDINO DE
1950–1975 *Florentine Codex: General History of the Things of New Spain.* 13 parts (A. J. O. Anderson and C. E. Dibble, trans.). Monographs of the School of American Research and the Museum of New Mexico 14. Santa Fe.
SALOMON, FRANK
1986 *Native Lords of Quito in the Age of the Incas.* Cambridge Studies in Social Anthropology 59. Cambridge University Press, Cambridge.
1987 Ancestors, Grave Robbers, and the Possible Antecedents of Cañari "Inca-ism." In *Natives and Neighbors in South America* (Harald O. Skar and Frank Salomon, eds.): 207–232. Ethnologiska Studier 38. Göteborgs Etnografiska Museum, Göteborg.
SÁMANO-XEREZ
1937 [1528] Relación. In *Cuadernos de Historia del Perú.* No. 2 (Raúl Porras Barrenechea, ed.): 63–68. Imprimeries Les Presses Modernes, Paris.
SAUER, WALTHER
1971 *Geologie von Ecuador.* Gebrüder Borntraeger, Berlin.
SAVILLE, MARSHALL
1900 Cruciform Structures near Mitla. *Bulletin of the American Museum of Natural History* 13: 201–218.
SCHAEDEL, RICHARD
n.d. Commerce in Ancient Peru. Ms. on file, 1988,

Department of Anthropology, University of Texas, Austin.

SCHÖNDUBE B., OTTO

n.d. *Tamazula-Tuxpán-Zapotlán: Pueblos de la frontera septentrional de la antigua Colima.* Tésis profesional, Escuela Nacional de Antropología e Historia; Tésis de maestría, Universidad Nacional Autónoma de México, Mexico, 1974.

SCOTT, DAVID A.

n.d. Ancient Bronze, Copper-Arsenic and Tumbaga Alloys from South America: Some Ecuadorian Aspects. Ms. on file, 1988, The Getty Conservation Institute, Marina del Rey.

SCOTT, DAVID A., and WARWICK BRAY

1980 Ancient Platinum Technology in South America. *Platinum Metals Review* 24(4): 147–157.

SHIMADA, IZUMI

1985a Perception, Procurement, and Management of Resources: Archaeological Perspective. In *Andean Ecology and Civilization* (Shozo Masuda, Izumi Shimada, and Craig Morris, eds.): 357–399. University of Tokyo Press, Tokyo.

1985b La cultura Sicán: Caracterización arqueológica. In *Presencia Histórica de Lambayeque:* 76–133. Editorial Mendoza, Chiclayo.

1987a Horizontal and Vertical Dimensions of Prehistoric States in North Peru. In *The Origins and Development of the Andean State* (Jonathan Haas, Shelia Pozorski, and Thomas Pozorski, eds.): 130–144. Cambridge University Press, Cambridge.

1987b Aspectos tecnológicos y productivos de la metalurgia Sicán, costa norte del Perú. *Gaceta Arqueológica Andina* 4(13): 15–21.

n.d.a Llama and Cash Flow on the Prehispanic Peruvian Coast. Paper presented at the 49th Annual Meeting of the Society for American Archaeology, Portland, 1984.

n.d.b A Metallurgical Survey in the Vicús Region of the Far North Coast of Peru. Paper presented at the 7th Northeast Conference on Andean Archaeology and Ethnohistory, Amherst, 1988.

SHIMADA, IZUMI, STEPHEN M. EPSTEIN, and ALAN K. CRAIG

1982 Batán Grande: A Prehistoric Metallurgical Center in Peru. *Science* 216: 952–959.

1983 The Metallurgical Process in Ancient North Peru. *Archaeology* 36(5): 38–45.

STOTHERT, KAREN E.

n.d.a Preliminary Report of the Río Tambo Project, Santa Elena Peninsula, Ecuador. Ms. on file, 1984, Museo Antropológico del Banco Central del Ecuador, Guayaquil.

n.d.b The Origin and Development of Prehistoric Chiefdoms on the Santa Elena Peninsula, Ecuador. Ms. on file, 1987, Center for Archaeological Research, University of Texas, San Antonio.

SZÁSZDI, ADAM

1980 Módulo experimental para la interpretación de las hachas monedas de la costa ecuatoriana. *Cuadernos Prehispánicos* 8(8): 69–76.

TROIKE, NANCY

n.d. Bishopric of Nueva Galacia. Ms. on file, Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México, Mexico.

UBELAKER, DOUGLAS H.

1981 *The Ayalán Cemetery. A Late Integration Burial Site on the South Coast of Ecuador.* Smithsonian Contributions to Anthropology 29. Smithsonian Institution Press, Washington, D.C.

UNITED STATES DEPARTMENT OF AGRICULTURE, FOREST SERVICE

1947 *The Forests of Western and Central Ecuador.* Washington, D.C.

VENTURA, BEATRIZ N.

1985 *Metalurgia: Un aspecto poco conocido en la arqueología de las selvas occidentales.* Programa de Estudios Prehistóricos: Informes de Investigación 2. CONICET—Universidad de Buenos Aires, Buenos Aires.

VIDAL, CÉSAR, and ROGER CABOS

1983 Zoneamiento regional de las alteraciones y menas hidrotermales en Hualgayoc, Cajamarca. *Boletín de la Sociedad Geológica del Perú* 71: 117–120.

WASSÉN, S. HENRY

1972 A Problematic Metal Object from Northern Peru. *Göteborg Etnografiska Museum. Årstryck:* 29–33.

WEBB, JR., JAMES L. A.

1982 Toward the Comparative Study of Money: A Reconsideration of West African Currencies and Neoclassical Monetary Concepts. *International Journal of African Historical Studies* 15(3): 455–466.

WEITLANER, R. J.

1947 Exploración arqueológica en Guerrero. In *El Occidente de México:* 77–85. Sociedad Mexicana de Antropología, Cuarta Reunión de Mesa Redonda, Mexico.

WEST, ROBERT

1961 Aboriginal Sea Navigation between Middle and South America. *American Anthropologist* 63: 133–135.

ZEVALLOS M., CARLOS

1988 La balsa. In *La balsa en la historia de la navegación ecuatoriana* (Jenny Estrada, ed.): 143–168. Instituto de Historia Marítima, Guayaquil.